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PART III.

July, 1838.

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THE CYCLOPÆDIA

OF

ANATOMY AND PHYSIOLOGY.

EDITED BY ROBERT B. TODD, M.D.

Professor of Physiology and of General and Morbid Anatomy in King's College, London, Physician to the Western Dispensary and to the Royal Infirmary for Children, &c. &c.

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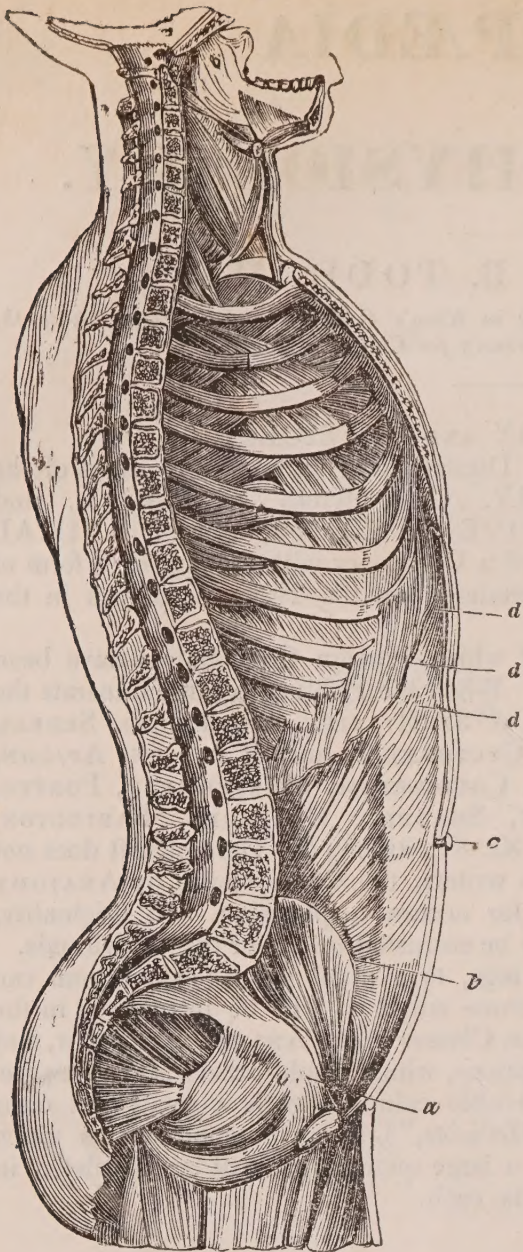
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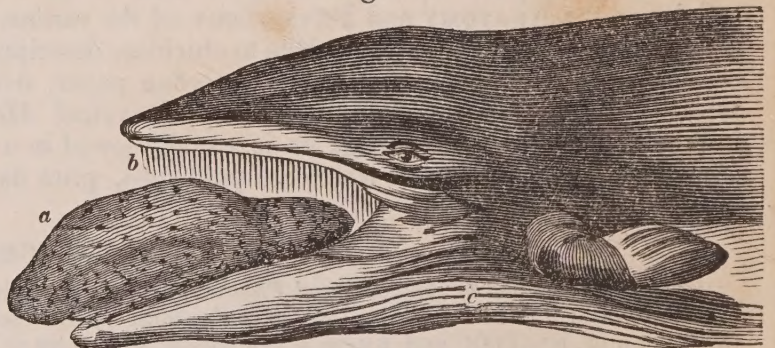


ABDOMINAL CAVITY, (in human anatomy.)
The annexed woodcut exhibits a vertical section of the body intended to show the thoracic and abdominal cavities, from which the viscera have been removed. A simple reference to it and to *fig. 204* will sufficiently explain the form and boundaries of the latter cavity, which have been already fully described in the article **ABDOMEN**. Our object in the present article is to examine the abdominal cavity as it is brought under the eye of the anatomist, when its contents have been exposed by removing or cutting through the abdominal parietes.

It rarely happens that we meet with an instance in which the abdominal viscera have not been more or less disturbed after death from their natural relations to one another. During life the contractile walls of the abdomen, ever active, maintain such a uniform degree of pressure on the contained organs, that displacements or alterations of positions are very rare occurrences excepting through some preternatural opening in the abdominal parietes. It is advisable to study the positions of the contents of the abdomen in a body recently dead, and which has not experienced any degree of disturbance.

CETACEA.

Fig. 259.



*Tongue and Baleen-plates of the Piked Whale, Balænoptera Boops.**

AVES.

Order I. RAPTORES.

Body, very muscular.

Beak, strong, curved, sharp-edged and sharp-pointed, often armed with a lateral tooth; upper mandible the longest. (*Fig. 112.*)

Legs, robust, short, with three toes before, and one behind; all armed with long, strong, crooked talons. *Fig. 113.*

All the Birds of Prey feed on the flesh of living or recently killed animals. They have a prompt, powerful, and rapid flight. They are monogamous; the female exceeds the male in size. They nidificate in lofty situations and rarely lay more than four eggs: the young are excluded in a blind and feeble state.

Fig. 112.



Fig. 113.



The tongue itself corresponds to the form of the space included by the rami of the lower jaw, and is consequently of great size in the Cachalots and Balænidæ, rising in the latter like an immense cushion (*a*, *fig. 259*), into the space between the laminæ of baleen (*b*), and affording a great quantity of the finest oil. In the figure it is represented in the Piked Whale, but probably preternaturally enlarged and raised by the extrication of gas caused by putrefaction. It is thick, and its free extremity is generally short, but this is less remarkable in the *Phytophaga* than in the *Zoophaga*.

* From Fr. Cuvier, *Cetacea*, pl. 20.

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is a preparation of an artery, the vasa vasorum of which were injected after a ligature had been applied to it, and the internal clot is distinctly reddened with the injection. John Hunter, however, was doubtful whether the red colour of the clot was produced from injected vessels or from effusion. That the fibrinous concretions found within an aneurismal sac are organized also, appears extremely probable, from the masses of coagulable lymph which are found within the cavities of the heart, in many instances adhering to, and having a distinct vascular connection with, the endocardium or lining membrane of the heart ; but what appears to me to confirm the opinion of the fibrinous concretion in an aneurismal sac being organized, and being an effusion from the vasa vasorum, is the fact of the coagulum formed in an obstructed vein having been distinctly injected by Mr. Kiernan. A branch of the vena porta had been compressed by a tumour and plugged up by effused lymph, and the arteries having been filled with fine injection, the coagulum was reddened on some points and a very considerable sized vessel is exhibited in the preparation passing from the internal coat of the vein into the coagulum.

Whilst, therefore, red blood may coagulate in an aneurismal tumour, merely by the diminution in the force of the circulation as shall hereafter be pointed out, the formation of an organized fibrinous concretion must be the result of a different process, and can only be explained by supposing fibrine to be effused from the internal surface of the sac itself, in like manner as coagulable lymph is effused on the surface of an inflamed serous membrane.

Coagulated blood.—The coagula of red blood are very distinct, as I have already said, from the concreted fibrine or coagulable lymph which is in immediate contact with the internal surface of an aneurismal sac. Coagula are sometimes found in distinct masses, in contact with the concreted fibrine, and sometimes portions of the fibrinous concretion, which hang loose in the cavity of the aneurismal sac, are surrounded with coagula of blood.

These two different substances, the laminated fibrinous concretion, and the coagulated red blood, both of which are found within the aneurismal sac, ought, therefore, to be discriminated from one another, more particularly as the artificial means which may be adopted to further the production of the one may not be such as are best calculated to promote the formation of the other : and hence, when a surgeon speaks of effecting a coagulation of the blood within the sac of an aneurism, he ought to consider, whether the means employed be intended to promote the formation of a fibrinous concretion, or whether they will merely produce a coagulation of some of the red blood contained within the sac.

The anastomosing vessels.—It has been stated (see ANASTOMOSIS) that no sooner is the circulation in an arterial canal diminished, or

altogether interrupted, than the anastomosing vessels enlarge to supply the deficient quantity of blood. This change in the inosculating branches is distinctly seen in those of the head, when the carotid artery of the opposite side has been tied ; the various ramifications of the temporal and occipital arteries acquiring a very considerable increase in their bulk, and becoming tortuous. But if, during the “spontaneous cure” of an aneurism, the circulation of the blood in the artery be gradually diminished, a corresponding degree of dilatation will take place in the collateral branches. And again, if a ligature be applied to a diseased artery for the cure of an aneurism, from the circumstance of the inosculating branches having been already employed, for a longer or shorter period, in performing the functions of the obstructed vessel, the anastomosing branches will not have to undergo the same degree of change as would have been requisite had the trunk of an artery been suddenly obstructed. It has also been stated, that whilst a vast number of anastomosing branches are, at first, called upon to perform, by their co-operation, the function of an obstructed trunk, the number of dilated branches gradually decreases, and ultimately the function of the obstructed vessel is performed by only one or two enlarged anastomosing branches,—and these are found in the very site of the vessel on which the ligature has been placed. (*A. Cooper.*)

Predisposing causes.—In almost every case of aneurism of spontaneous formation, the coats of the artery have been diseased previously to the formation of the tumour, and even in those cases where the aneurism has formed after some violent exertion, there is always reason to suspect that the coats of the vessel have undergone some previous morbid change. An artery, in its healthy state, possesses elasticity sufficient to preserve its natural calibre, notwithstanding any violent muscular efforts, or any inordinate accumulation of blood. But if the power of resistance of the coats of the artery be diminished in any part of the vessel, it can readily be conceived how the coats may then give way, gradually or suddenly, before the lateral impulsion of the blood, and an aneurism be thus formed. The changes in the structure of an artery, which predispose to the formation of aneurism, are a diminution in the natural elasticity of the coats of the vessel usually accompanied with the deposition of an earthy or calcareous looking matter, or even of bone betwixt the interior and fibrous coat,—all which changes are generally supposed to be the consequence of chronic inflammation. In losing their elasticity, the tunics of an artery are observed to be more or less friable. But whether the changes of the arterial structures are referable to arteritis in an acute or chronic form, or whether this degenerescence takes place from other, and perhaps unknown causes, will be discussed in another place. (See ARTERY.) If the entire circumference of the vessel be affected, the dilatation will be equal on all sides, all the tunics yielding at the

same time; this is the *fusiform* dilatation. But if the change has taken place partially in the artery, and affects only one of its sides, the enfeebled portion only of the tunics will yield, and the dilatation will then be partial. The fusiform dilatation is now regarded by most pathologists as a precursor to the more common lateral dilatation, and in which, if it continues to make progress, it ultimately terminates. An artery, however, may undergo dilatation without any disease of its tunics. But this condition differs essentially from that of an aneurismal sac, and will be noticed hereafter.

Proximate Causes.—Besides different constitutional disturbances, such as arise from rheumatism or gout, and which cause changes in the structure of the arterial system, aneurisms can usually be traced to some violent or sudden exertion, or to some mental excitement. An aneurismal swelling often arises from a violent fit of coughing, sneezing, vomiting, or leaping. A man, who had an aneurism of the innominate was seized with a long paroxysm of sneezing; after which he first perceived the aneurismal tumour. Another person, who had a carotid aneurism, first noticed the tumour after a violent fit of coughing. A third person, on leaping a ditch, slipped; at the moment, he felt a snap in the ham, after which an aneurism formed in the popliteal artery. In another case, a person, on attempting to raise himself in bed, on his hands, felt something snap on the back of his right hand, when an aneurism formed on the radial artery. (*A. Cooper.*) In a word, when the predisposition exists, the disease may be developed by causes apparently slight, acting either directly on the vessel itself, or indirectly on the heart.

How an aneurism is caused by a sudden exertion or violent muscular effort, may, I think, be readily explained now that the influence of muscular contractions on the arterial circulation has been pointed out (vide the author's work on Diseases of the Heart). If the pressure of a contracted muscle on an artery have the effect of diminishing the impetus of the current of the blood, or of arresting it entirely, the result of thus stopping the circulation in a diseased artery must sometimes be such as to cause the diseased tunics of the vessel to give way, and an aneurism to be formed.

Attempts have been made to *imitate* the formation of an aneurism by experiments on the arteries of animals. For this purpose, John Hunter laid bare the carotid artery of a dog, and afterwards "skinned it with a knife, even to transparency," but no dilatation of the vessel took place. Three weeks afterwards, the animal was killed, and the artery on which the experiment was made, in place of being dilated where the external tunic had been detached, was found thickened by the inflammation, and subsequent adhesion of the adjacent cellular structure. The result of Hunter's experiments, however, were in direct contradiction to some which had been made by the illus-

trious Haller, who asserted, that he could readily produce an aneurism in dogs, by separating the cellular or fibrous coat of their arteries, and leaving denuded the internal tunic. The discrepancy in the results of the experiments of these two eminent pathologists was, however, readily accounted for by the difference of the mode in which their experiments were conducted; for whilst Haller left the denuded vessel to remain isolated and separated from the adjoining soft parts, Hunter allowed the artery and the surrounding cellular tissue to unite, and hence the parietes of the vessel, in place of being more yielding, as in Haller's experiment, became absolutely firmer, and thus capable of making a greater resistance to the impetus of the blood. The experiments of Hunter, therefore, may be adduced as examples of the powers the system possesses for repairing an injured artery; while those of Haller show that the internal membrane of the artery is not alone sufficient to resist the impetuosity of the circulation, and hence, when the two external tunics of an artery are ruptured or destroyed by disease, an aneurismal tumour may be formed by the distension of the internal coat alone.

Experiments have also shown that the force of the blood's current is not sufficient to dilate the external coat of an artery when the fibrous and inner coats have been ruptured by temporarily tying a ligature tightly round the vessel. In place of the external cellular tunic giving way, and forming an aneurismal tumour, the powers of nature are exercised here as after wounds, in restoring the injured parts by the effusion of coagulable lymph, and this happens in some instances to such a degree as to obstruct the flow of the blood, and entirely interrupt the circulation through the artery.

Whilst artificial means of producing an aneurism by destroying the external or cellular coat of arteries in a living animal have failed, experiments have shown how readily in the *dead body* an aneurism or bulging of the cellular coat can be produced by forcibly injecting either air or water into an artery, when the internal and fibrous coats have been previously divided. By injecting water into the pulmonary artery with such a degree of force as to rupture the internal and middle coats, Nicholls found that the external coat became distended. Having divided the internal and middle coats of different arteries by the application of ligatures, Hodgson also found that, by forcibly inflating the vessel, "the external tunic always exhibited a sufficient degree of dilatation to prove that it is more liable to yield and to be expanded into a sac, than to be ruptured by the impulse of the blood." But the same experiment in a living animal produced a very different result; and Jones proved that the laceration of the internal and middle coats of a healthy artery was not followed by a dilatation of the cellular coat, or by the formation of an aneurism, but that fibrine was effused on the injured surfaces which, in place of enfeebling, rendered the

parietes of the artery firmer at that point. It must, however, be very different when the coats of an artery which are in a diseased state give way, for then the restorative powers of nature are not sufficient to strengthen the lacerated coats, and the force of the blood's circulation becomes sufficient to distend the cellular coat and to form an aneurismal pouch. We would not, however, be understood to offer this as a perfect explanation of the etiology of aneurisms in general. Other influences, doubtless, may have a share in their development, and we by no means contest the point; on the contrary, we admit that there is still a good deal of obscurity in the history both of the predisposing and proximate causes of this affection. All we mean to say is, that the impossibility of producing aneurism by experiment on healthy arteries, does not invalidate the influence in its production of those organic alterations of the arterial tunics.

Aneurisms are observed to form most frequently in certain arteries, and in particular parts of them. The arterial trunks of the first magnitude become aneurismal much more frequently than those of inferior calibre, and hence internal are much more frequent than external aneurisms. Aneurisms are most frequently formed at the curvature of these arteries, and where they divide into branches. The aorta, particularly at its arch, is more frequently affected with aneurism than any of its branches; and this observation accords with the theory, that the lateral impulsion of the blood concurs in the production of aneurism when the structure of the artery has undergone a change: the curves formed by the arteries being precisely the points where this impulsion is greatest, and where aneurism occurs most commonly. The innominate, subclavian, carotid, axillary, iliac, and femoral arteries, are subject to aneurism next in frequency, whilst the temporal and occipital arteries, those of the leg, foot, and forearm, and the arteries within the cranium, are rarely found to be aneurismal. The peculiarity in the structure of the arteries within the brain is one reason why a destruction of their coats is much more frequently followed by an extravasation of blood than by the formation of an aneurism. It sometimes happens that an aneurism is formed at the point where a branch is sent off from the arterial trunk. When this takes place, the branch, if they should be but one, is sooner or later detached from the parent trunk by the progress of the tumour, which is as it were interposed between them. The mechanism of this transportation is thus explained by Berard (*Archives Gén. de Méd.*, July 1830 :) the internal and middle tunics having yielded around the origin of the vessel, it is now connected with the trunk through the cellular tunic only, and in proportion as the sac becomes distended, the branch becomes the more distant from the artery which gave it origin. The arterial branches which are thus de-

tached, are usually found to be obliterated at their point of communication with the sac, having undergone adhesion by effusion of plastic lymph from the internal surface of the cellular tunic, or being plugged with coagulum, which has formed in consequence of the languid state of the circulation in those branches; but this occlusion of the vessel seldom extends beyond the next collateral, so that the circulation, so far from being cut off by the adhesion or plugging of the transported orifice, is on the contrary rendered more vigorous by the dilatation which is thus produced in the anastomosing branches, while it favours, at the same time, the coagulation of the blood in the aneurismal sac itself.

Effects of an Aneurism on the surrounding Structures.—There is a tendency in the living fibre, to whatever class it may belong, to degenerate when condemned to perfect repose. In the case of an increasing aneurismal tumour, this cause of degradation is promoted by the pressure which the tumour itself produces on the surrounding parts. But this is not all; organs are displaced, blood-vessels are obliterated, nerves are stretched, muscles are distended and atrophied, and even the bones and cartilages are altered and destroyed. It must be obvious therefore, that when such a variety of structures is successively involved in the progress of an aneurism, that the symptoms which accompany its development will have relation to the nature and functions of these several tissues: thus when the muscles are compressed, elongated, or disturbed from their natural situation, their movements are impeded, perverted, or abolished; when the nerves are subjected to the same influences, the most intolerable pain is produced, and continues until they are wasted and disorganized, and then the pain gives place to numbness, which prevails throughout the whole limb; when the veins and lymphatics are acted on in the same way, some become obliterated while others are dilated, the limb feels cold, and is more or less œdematous; even the bones themselves are destroyed by the pressure and pulsation of an aneurismal tumour. This destruction, however, has no affinity to either caries or necrosis; the bone softens, and is then absorbed irregularly, but it neither suppurates nor dies, and this is a circumstance of some importance as regards the treatment that may be adopted, for if the progress of the tumour can be arrested by the ligature, the condition of the bone will not contra-indicate its application, as it must do, had the bone been affected with caries. This, however, is so far from being the case, that the portion of bone that has been spared is often found to be extremely hard. The cellular tissue disappears altogether, or is so wasted and thinned as to be undistinguishable from the sac of the aneurism itself; and the same may be said of all the other soft tissues, when the tumour is allowed to proceed unchecked, until it has no other covering than the common integument.

Number of Aneurisms.—Though it seldom happens that there is more than one aneurism in any individual, there are cases where many aneurismal tumours have been found after death. Dessault saw a man who had six aneurisms, and Delpech found no less than sixty in one individual. Such cases, however, are extremely rare, and though almost in every aneurismal patient many portions of different arterial trunks are usually found diseased, yet it seldom happens that the tunics have given way so as to form an aneurism at more than one place.

Fig. 61.

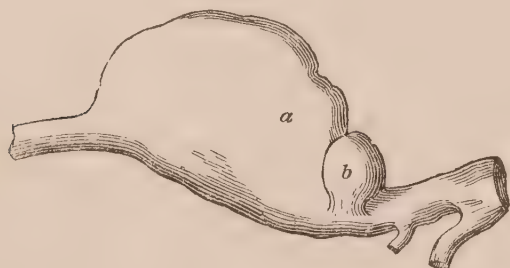


Fig. 61 is an outline of a large aneurism of the axillary artery (a), immediately contiguous to which, and on its cardiac side there is a smaller swelling (b), which not being recognised before an attempt was made to pass a ligature round the artery, was the cause of the impracticability and danger of the operation.

Progress.—In this respect there is great variety, not only as to the duration of the disease, but also as to the condition of the tumour itself. The progress of an aneurismal tumour is hastened or retarded by a great number of circumstances, and may therefore occupy many months, or even years. As regards the condition of the tumour, it may retain an uniform spherical appearance to the last, or, as it advances, it may become irregular, knobbed, and appear to be made up of several tumours formed in succession, according to the various degrees of resistance the different parts of its surface may have to encounter.

Dehaen states, that he had seen a case of aneurism which had been progressing for a number of years; while Hodgson, on the other hand, describes a case in which the disease ran through all its stages with extraordinary rapidity.—“An old man, who uniformly enjoyed good health, whilst walking in the street, was attacked with a sudden pain, and immediately perceived a small swelling in the middle of the right thigh. The pain increased, the swelling became larger, and in a few hours the whole limb was œdematous. The tumour was compressible, but no pulsation could be discovered in it until a short time before death, when an indistinct thrill was perceptible. He became extremely feeble, the swelling increased, and he died in three weeks from its first appearance. A quantity of grumous blood was found amongst the muscles of the thigh, which were separated to a considerable extent, so as to form a large cavity on the anterior surface of the triceps. The femoral artery communicated with this sac by a small round opening not larger than the calibre of the vessel. This opening was evidently

the mouth of a small aneurismal sac, which had suddenly burst, and given rise to the diffused extravasation, for the dilated and ruptured coats of the vessel were seen at the bottom of the cavity, reflected upon the external surface of the artery. The original sac could not have been larger than a pea, and was formed by a partial dilatation of the coats of the vessel, which were throughout much thickened, and covered with calcareous matter¹.”

Sex.—Aneurisms are much more frequently met with in men than in women, for whilst the sedentary habits of the female render her frame more particularly subject to certain diseases, aneurism, being usually caused by some violent muscular exertion, might be anticipated to befall men much more frequently, not only from their avocations, but also from the circumstance that the arterial system is in them much more liable to disease.

Age.—Patients most usually affected with aneurisms are neither the very young, nor those far advanced in life. Those diseased states of the tunics of an artery which lead to the formation of an aneurism, are not often met with in young people; whilst the aged are seldom exposed to those great muscular exertions which by causing the coats of a diseased vessel to give way, lead immediately to the formation of an aneurism.

Diagnosis.—In the early stage of an external aneurism, its true nature is easily detected, but in a more advanced state, when it has attained a considerable magnitude, when the pulsations have become more indistinct, and when pressure produces no perceptible change in its volume, it is then often no easy matter to form a correct diagnosis. Under these circumstances, the history of the case must be the chief guide in ascertaining its nature. If the origin and progress of the disease have been such as in those cases we have already described as characteristic of aneurism, an opinion can then be formed with confidence. But it seldom happens that an account sufficiently clear can be obtained from the patient, to leave no doubt as to the true nature of the disease, and the difficulty is much increased when the tumour itself does not present any of the pathognomonic symptoms of aneurism. Thus, an aneurism has frequently been mistaken for an abscess, been laid open, and a fatal hæmorrhage has followed. Old aneurisms, too, have often been mistaken for swellings of a quite different nature, and tumours situated in the vicinity of large arteries which had the pulsations of the contiguous arteries communicated to them, have also been mistaken for aneurisms. An aneurism, however, may be distinguished from a tumour which is situated on the course of an artery by the history of the disease, and likewise by the character of the pulsations. Whilst an aneurism commences as a soft tumour, which disappears when subjected to pressure, most

¹ Hodgson, p. 71.

other tumours are, on their first appearance, of firmer consistence, and pressure produces no diminution in their size. An aneurism, as it increases in bulk, increases also in density, and the increase in its firmness commences at the circumference of the tumour and gradually extends towards the centre. In a tumour which has become soft by the process of suppuration, the fluctuation is on the contrary, first perceived in the centre, and gradually extends to the circumference of the swelling, and, therefore, the longer the tumour has existed, the softer will it generally be. The pulsations of an aneurism cannot be changed by any alterations in the position of the affected limb, but those of a tumour situated on the course of an artery will be altered by a change in the position of the limb, the tumour being displaced, the pulsations of the artery cease to be communicated to it; or a tumour may be distinguished from an aneurism by elevating the swelling from the artery from which it derives its pulsations.

The smaller the tumour and the more recent its formation, the more distinct will be the pulsations of an aneurism; but the pulsations of other swellings are more evident in proportion to their size, owing to the greater degree of pressure which they exert on the subjacent vessels.

Before much coagulum is deposited within the sac, in an aneurism, the pulsation is felt equally throughout the whole circumference of the tumour; and as it increases in size, and the coagulum becomes deposited in greater quantity in the sac, the pulsation will be felt only at the centre of the swelling; in a still more advanced state of the disease, when there is a thick coagulum deposited, the pulsations are obscure or not at all perceptible. The movement discernible in a tumour placed on the course of an artery is not that effort of dilatation which an aneurism presents, but a lifting or displacing of the whole mass of the swelling.

When collections of purulent matter form in the vicinity of an artery, the vessel communicates a motion to the fluid in the tumour similar to that of an aneurism; and the diagnosis is rendered very difficult, if there have not been symptoms which would lead to suspect the formation of pus.

In order to distinguish between an aneurism and an abscess formed in the course of an artery, we must remember that the latter is preceded by certain local and general symptoms, more or less evident, such as inflammation, rigor, &c., that the tumour, when pressed upon, remains unchanged as to bulk, and that it is elastic. In the case of a cyst, the mistake is less likely to be made; for though in aneurismal tumours of long standing, the circumference feels hard, owing to the laminated deposits of fibrine, still its centre will afford signs of fluidity, and its size will be increased or diminished according as pressure is made either on its cardiac or capillary side. It also sometimes happens that an aneurismal tumour

in its progress to the surface, gives rise to inflammation of the cellular tissue, and the formation of an abscess: here the purulent collection masks the more serious affection, and an error of diagnosis may be easily committed. In such cases, whether the pus be evacuated or not, the progress of the aneurismal tumour becomes very rapid, and prompt measures must be resorted to, in order to save the patient from the hæmorrhage, which is imminent. The diagnostic, as in the former instance, can only be guarded by referring to the history of the case.

When, notwithstanding our best endeavours, we are not fortunate enough to remove all doubts, and more especially if the tumour has been stationary for some time, it will be best to abstain from any interference with it; time, and repeated examinations in every variety of posture, will often dispel the obscurity. But if, on the other hand, the tumour continue to make such progress that, if left to itself, it must soon be beyond the reach of art, the pain becoming intolerable, and the limb œdematous; in a word, if more serious mischief threatens to result from our leaving the tumour to itself, than can follow from an attempt to clear up the diagnosis, then it will be justifiable to make an exploratory puncture with a needle, or small trocar. The surgeon will have only to act according to the indication he obtains. Should it be arterial blood, the case becomes clear. The small puncture will not give rise to hæmorrhage, if it be firmly covered with adhesive plaster. But after this, delay would not only be improper, but dangerous. He must concert the measures to be taken, and carry them into effect, after as brief a period of preparation as the circumstances of the case may require.

The advantage in an obscure case, of repeated examinations of the tumour after intervals of several days is this, that the pulsation may be present at one time, and absent at another, a circumstance which is easily explained: the pulsation is strong when the communication between the artery and the sac is free; but if the opening be small, and blocked up by a coagulum, the thrill will be obscure, and often imperceptible, until the coagulum becomes displaced.

When all the signs of an aneurism are equivocal, the stethoscope may be of use, and will often enable us, even in advanced cases, to detect the bellows', or rasp sound, produced by the entrance and exit of the blood in the tumour at each contraction of the heart.

There can be no more convincing proof of the difficulty of forming a diagnosis of aneurism, than the fact that in some cases very contradictory opinions have been given by eminent practitioners. A female had a tumour about the bulk of a hen's egg, which formed in the site of the subclavian artery; and such was the difficulty in ascertaining its true nature, that one surgeon was of opinion it was an aneurism; another thought it was a glandular swelling; a third suspected it to be an aneur-

ism, and a fourth would not give a decided opinion. The patient followed Valsalva's system of treatment, and got well, though no circumstance subsequently occurred by which the precise nature of the tumour could be distinguished.

The signs presented by an aneurism situated within any of the great cavities, are generally very obscure, until it has attained a considerable size, and then the symptoms depend on the effects of the compression of the tumour on the surrounding organs. Thus, an aneurism within the cranium will cause a disturbance in the function of the brain; or within the chest, will influence the respiratory organs; and in the abdomen it will produce more or less derangement of the digestive apparatus.

The indistinct pulsation which may be detected in the thorax and abdomen may be referred to other causes. In the thorax it may arise from an affection of the heart, and in the abdomen from a derangement in the digestive apparatus, causing an increase in the circulation. Thus the diagnosis of aneurism within the great cavities is very obscure, whilst they remain within those cavities; but when they have made such progress as to appear externally, after destroying the soft parietes of those cavities, or the bones which oppose their development, then their true nature is no longer concealed.

A true aneurism has often been confounded with the *dilatation of a vessel*, and it is of importance to distinguish these two very different conditions of an artery, not only because their anatomical characters are essentially different, but the mode of treatment applicable to the one disease is not necessary for the other.

When an artery is preternaturally *dilated* the enlargement is not limited, as in aneurism, to a particular portion of the vessel, but its whole circumference is augmented, though not to an equal degree in every part; and in place of the tunics of the artery being thickened, they are thinner than natural—each of them is equally dilated, and there is no coagulable lymph or fibrine effused on their internal surface. The portion of the artery thus dilated has indeed more the appearance of a vein than of an artery—particularly a portion of vein which has been repeatedly punctured in the operation of phlebotomy, the coats being condensed and assimilated together in such a manner, as to render them not easily separable from one another. The circumstance of a dilated artery not being lined with a fibrinous concretion forms a striking difference between this pathological condition of an artery and a true aneurism; for whilst the sac of an aneurism is protected, and its rupture prevented, by the additional thickness which it receives from the effusion of fibrine, the circumstance of the economy not having recourse to the same means of protection in cases of simple dilatation, ought to be considered as an incontrovertible proof of an

essential difference in the condition of an *aneurismal* artery from that of a vessel wherein there is simply dilatation.

Dilatation is most frequently observed in the aorta, but it is usually accompanied in that vessel by a diseased state of the coats, similar to that which precedes or accompanies aneurismal swellings; but the simple dilatation of an artery happens, I believe, most frequently in the innominate, subclavian, and carotid arteries, and it usually takes place where the vessels divide. In these arteries, the dilatation is apt to be mistaken for aneurism—a mistake which I have known to be made, and which I have myself once committed. The dilatation of an artery can, however, be readily distinguished from an external aneurism, from the great thinness of the parietes of the whole tumour, compared with that of an aneurism, from its form being more elliptical than globular, from its slow growth and often stationary character, and also from its never bursting or acquiring the volume of an aneurism. It ought also to be observed, that the two diseases, dilatation and aneurism, may both exist at the same time, and that the coats of a dilated artery may give way and form an aneurism, as has been stated in another place.

Fig. 62.



Fig. 62 represents a portion of the femoral artery dilated, in which is also two aneurismal swellings. (a a) is the arterial tube; (b) is the internal membrane of the vessel dilated, separating and progressing through amongst the fibres of the middle coat; (c c) the circular fibres of the middle coat, some of which are separated so as to permit the internal coat to form a sort of hernia; (d, d, d,) different portions of cellular coat divided to show the internal structures, (Breschet).

Prognosis.—Aneurism, in whatever part of the arterial system it may occur, always constitutes a disease of a serious character, the degree of danger depending on the size of the affected vessel, the state of the arterial system generally, the manner in which it appears to have been produced, the part of the body in which the diseased vessel is situated, and the age and general health of the individual. If the formation of the tumour cannot be attributed to any injury or severe bodily exertion, but has come forward in a very gradual manner, the danger is greatest; for then, in all probability, the aneurism is connected with a more extensive affection, not only of the aneurismal artery, but perhaps of the whole arterial system. It was remarked, when speaking of the condition of an artery where an aneurismal tumour existed, that the coats of the vessel were almost in every case diseased previously to the formation of the aneurismal tumour; it will, therefore, sometimes happen that the disease of the coats will also exist at the very

point where the ligature is about to be applied for the cure of the disease, and hence one cause of many of those fatal hæmorrhages which have taken place after operations of aneurism. If the aneurism occurs in a healthy constitution, in a part of the body within reach of surgical treatment, and has been caused by an injury, the case is not of so grave a nature. But experience has shown that even the existence of more than one aneurism, in an external situation, does not present an insurmountable obstacle to the successful treatment of the disease. Two aneurisms in the same person have been in several cases cured by the applications of ligatures on the femoral arteries.

Home tied both the femoral arteries in the same person for popliteal aneurisms in both limbs: the interval between both operations being only five weeks. Freer also operated in a similar case. Valentine Mott, of New York, treated a third case after the same manner, the interval between the two applications of the ligature being only fourteen days. The result, in all these cases, was successful. But the aneurismal tumours were all external. As regards the nature of the prognosis, a distinction is made, and very properly, if one of the tumours happen to be internal. In such a case, if a ligature be placed on the artery for the cure of the external aneurism, it will have the effect of accelerating the progress of the internal one, and the operation therefore would be not only useless, but mischievous.

In general, when the affection is of long standing, and has involved the surrounding parts to a considerable extent, the collateral vessels are often so extensively obliterated, as to be insufficient for nourishing the limb. An aneurismal tumour that has attained an enormous bulk, may already have produced alterations of so serious a nature in the muscles, nerves, articulations, and even in the bones, that a favourable prognosis, as regards the cure by ligature at least, cannot be entertained. In such cases, amputation only can save the patient. When gangrene attacks an aneurismal tumour, the danger is imminent; but even in such cases, the ligature may still be applied. Sir A. Cooper tied the external iliac artery in two cases of inguinal aneurism in which gangrene had already commenced. The tumours suppurated kindly, and the sacs becoming covered with granulations gradually cicatrized.

In aneurisms, as in all other affections of a serious nature that require operations, the general state of the patient must be taken into account, for the gravity of the case may often depend more on this, than on the local disease. In a scorbutic, syphilitic, or gouty diathesis, the prognosis cannot be otherwise than unfavourable.

TREATMENT.

From the dangerous nature of aneurism, its treatment has necessarily engaged much at-

tention, and it will be found that the different therapeutic means which have been successfully employed for the cure of this disease have all been in strict imitation of those spontaneous curative processes which have already been described. As the spontaneous cure of an aneurism is effected by laminæ of concreted fibrine lining, and even completely filling up, the sac, thus enabling it to resist that impetus of the blood which causes the enlargement or rupture of an aneurismal tumour, and as the formation of a fibrinous concretion, or the process of coagulation, as it has been usually denominated, proceeds more or less quickly, according to the force of the circulation of the blood in the tumour, any endeavour to cure the disease must be conducted with a view either to diminish or entirely arrest the circulation of the blood within the sac. Two principles of treatment have, therefore, been held in view for the cure of aneurism; the one having for its object to diminish the force of the circulation, and the other completely to prevent the circulation of the blood in the tumour. The first of these is effected by lessening the vigour of the action of the heart, and diminishing the quantity of the general mass of blood; whilst the second is to produce a mechanical hinderance to the flow of blood within the sac.

Valsalva's method.—For the treatment of aneurism according to the first mode, the system generally employed has been that which was originally proposed by Valsalva, and which many others since his time have successfully adopted. Valsalva conceived that a radical cure of aneurism might be accomplished by reducing the force of the circulation to a degree compatible merely with the continuance of life, and this he effected by repeated abstractions of blood, first in large, and then in small quantities,—by limiting the quantity of food and drink, and likewise preventing, as much as possible, any inordinate action of the heart, by keeping the patient constantly in a supine posture, and avoiding all mental excitement. This system of treatment was carried by Valsalva to such an extent that, “ultimately the patient was only allowed half a pint of soup in the morning, and a quarter of a pint in the evening, and a very small quantity of medicated water. When so reduced that he could not raise himself in bed, the quantity of nourishment was again gradually increased, until his strength was restored.”

Experience amply proved the efficacy of Valsalva's system of treatment, and there is the testimony of many eminent men of the progress of numerous aneurismal tumours having been arrested, and others completely cured, by this depletive system.

It happens, however, that this plan of treating aneurism, as recommended by Valsalva, is not very generally adopted, more particularly in this country, and this may arise partly from the important advancement which has of late

years been made in the surgical treatment of external aneurisms, and also from the opinion generally promulgated, that by debilitating a patient by a long-continued depletive system, although the impetus of the blood's current will be diminished, yet the change produced in the chemical qualities of the sanguineous fluid will be the means of impeding, instead of promoting that very process of coagulation which it is the primary object of the treatment to fulfil. "It ought to be admitted," observes Velpeau, "that it is difficult to comprehend how the treatment of Valsalva is efficacious. Without doubt, by blood-letting frequently repeated, and a rigorous diet, we are able to reduce the force of the heart and the pulsations of an aneurismal tumour. The volume of such a tumour may be diminished in the greater number of cases, but is it not to be feared that by enfeebling a patient we shall increase the fluidity of the blood; and that far from favouring its concretion, the consolidation of the aneurism and the obliteration of the artery, we, on the contrary, render all these different phenomena more difficult?"

In proof, however, of the soundness of the practice of Valsalva, and of the erroneous theory of its *rationale*, the researches of modern physiologists on the properties of the blood afford most satisfactory evidence; for whilst it has long been well known that in proportion as an animal is depleted, so does the quantity of the fibrine become *diminished*, it is a curious and no less important fact, "that fibrine coagulates the more speedily in proportion as the circulating and nervous systems become more feeble." The experiment has been repeatedly made with animals by bleeding them to death, the last portion of blood being found invariably to coagulate the soonest, and, as has been justly observed, "the principle of the blood's concretion being in the ratio of the debility of the animal from which it is withdrawn, is one of those wise provisions of which we see numerous examples in the living body¹."

This important discovery of the property of the fibrine of the blood to coagulate more and more speedily in proportion as the person has been depleted, explains how, by the more ready coagulation of the fibrine, when life has been nearly extinguished, the divided vessels are speedily sealed up, and the bleeding arrested. In like manner, we can satisfactorily account for the successful practice of Hippocrates, who, in hæmorrhage from the lungs, employed blood-letting along with the antiphlogistic regimen, so far as to exsanguinate the patient and produce excessive debility.

For establishing the plan of treatment of aneurism proposed by Valsalva, we therefore have not only the practical result of such a system, but physiological science enables us to give a most satisfactory explanation of its

modus operandi, and one important inference we are entitled to draw is, that not only ought this mode of treatment to be adopted in internal aneurisms, or those beyond the reach of the surgeon, but that it may be advantageously resorted to in cases wherein an operation may be ultimately advisable, because such treatment will not only greatly ensure the success of an operation, by tranquillizing the action of the heart and arteries, but will render the system less liable to inflammation, and may be the means of checking the progress of that disease in the coats of an artery which leads to the formation of aneurism and favours its future growth.

Besides the means recommended by Valsalva, there are additional measures which ought to be employed in the medical treatment of aneurism, and it is important to bear in mind, that even when all these means combined fail in curing, or in arresting the progress of the tumour, the patient is in a position wherein a surgical operation would be undertaken with a better chance of success than if such previous system of treatment had not been adopted. Of these means, the most important is the exhibition of those remedies which are known to have a specific effect in diminishing the action of the heart and arteries. In the use of *antimony* I have the greatest confidence, and have found the James's powder superior to all the other preparations of that mineral. From three to six grains of this powder may be given every six, eight, or twelve, or twenty-four hours, either singly or combined, with one grain of the extract of rhubarb or aloes. The frequency of the dose may be diminished when nausea is produced; and the aloes or rhubarb may be omitted should they act too frequently on the bowels.

When the tartrate of antimony is to be administered, the third or fourth of a grain may be given two or three times a-day, either in solution, or made into a pill with rhubarb, aloes, or gentian. In either of these forms, antimony may be taken for a lengthened period, and it ought to be administered as long as it appears to have a decided influence on the organs of the circulation, in conjunction with the other means, which are at the same time adopted to diminish the bulk and increase the thickness of the parietes of the aneurismal tumour.

Local remedies, along with the depletive system of Valsalva, and the use of those remedies which tranquillize the circulation, also assist in checking the progress, if they do not effect the cure, of an aneurism. Of these, I may first mention the local abstraction of blood by the application of *leeches*, the number of which ought to be few, but their application should be repeated every day or every second or third day, according to the relief which they afford. This practice is particularly applicable to internal aneurisms; and I have, in many instances, considered it to be the means of relieving congestion, more particularly when the aneurism has been seated in the thoracic

¹ Thackrah.

cavity, and of diminishing the vascularity of the aneurismal sac and adjacent soft parts, to a greater degree than could be accomplished by general blood-letting.

Astringents and refrigerants have, along with the application of leeches, a decided influence in abating the local inflammatory symptoms, and likewise in diminishing the congestion of blood in the sac. Of these astringent remedies, there is no one more serviceable than the acetate of ammonia, or the superacetate of lead, diluted with rose or camphorated water. Diluted spirits and vinegar have also been employed for similar purposes, and the choice of these applications should be made according to their effects on the individual case, that being preferable which gives ease, and is most comfortable to the patient; and the best mode of using them, is by covering the tumour with a piece of lint which is kept moist during two or three hours, three or four times a-day.

In some cases *ice* may be employed with advantage, and is to be applied within a bladder after being sufficiently comminuted. Its use, however, requires great caution, and its application should not be continued when it creates pain or uneasiness.

Chemical agents.—It has been attempted, by Sir Everard Home, to cure an aneurism by causing the coagulation of the fluid blood within the sac by the application of heat.

“In a case of aneurism in the external iliac artery, in Chelsea Hospital, for the cure of which I tied the femoral artery *below* the sac, on the 16th September, 1825; finding that this operation neither diminished the pulsation, nor arrested the increase of the size of the tumour, I was led to introduce an acupuncture needle into the centre of the tumour, where the pulsation was most violent, and the fluid state of the blood most distinctly felt: the needle was passed through a small orifice in a bar of steel three inches long, the skin of the thigh was protected by cork, and the needle was heated through the medium of the steel by a spirit-lamp. In a few minutes the patient felt heat and pain in the centre of the tumour, but not very severe, so that the application was continued for fifteen minutes, during which the pulsation in the tumour was diminished; on withdrawing the needle, the orifice was marked by a single drop of coloured serum. In half an hour, intense pain was felt in the thigh; but this was not only removed in ten minutes by twenty drops of laudanum, but the thigh and leg became more easy than they had been for the previous twelve hours, and the throbbing in the sac was reduced to an undulation.

“This application of heat was not resorted to till the twenty-eighth day after tying the femoral artery, during which time the swelling had increased considerably in size. The man was forty-three years of age, had served eighteen years in the fourteenth dragoon guards, and was a hard drinker. For two days the tumour was easy, and the pulsation had be-

come less under the punctured part than higher up towards the belly. The tumour not diminishing, the operation was repeated on the thirty-fourth day from tying the artery; the needle and bar of steel double the size of those before used, and the application continued thirty-five minutes. The internal heat was greater than before, and the pulsation in the tumour much diminished. The needle was with difficulty withdrawn; a coagulum as hard as sealing wax, the size of a pin's head, being firmly attached to the middle of the needle. The pain the operation produced subsided in ten minutes; the internal heat continued twenty-four hours, and the tumour had now a solid feel: he was quite easy for two days, but on the third the pain and pulsation returned; also the inward pain in a still greater degree than while the needle was immersed, and the tumour was extremely tense. Under these circumstances, on the forty-fourth day after tying the femoral artery, I repeated the application of the acupuncture needle and steel double the size of those last employed: the heat felt internally was very great, but the pain was not much increased; after it had been immersed twenty minutes, the pulsation all at once stopped, and the needle was immediately withdrawn; the pain in ten minutes went off, and the patient was quite easy. From this time there was no pulsation in the tumour, which to the feel appeared solid, and therefore I considered the progress of the aneurism arrested; this was in some measure proved by the pulsation remaining violent in the external iliac artery down to the part pressed upon by the sac, but no further.

“Although the patient was free from pain, took his usual allowance of food, and relished his wine and porter as much as before, the foot, about the fiftieth day became cold to the touch, the thigh and the leg oedematous, and about the sixtieth day vesications made their appearance on the foot and leg; the skin lost its sensibility, and although he had little or no pain, the weight of the thigh took from him all power of moving it.

“These symptoms were the forerunners of mortification; the pressure from the tumour above preventing the leg from receiving a sufficient supply of nourishment; they did not, however, increase, and he remained in nearly the same state till the ninetieth day, when he died.

“The upper part of the thigh, which had been regularly measured, was found, on the forty-fourth day, to be twenty-four inches, and remained of the same size at his death—three inches and a-half beyond that of the other.

“On the examination of the parts after death, the external iliac artery was found to pass down in the front of the aneurismal sac; it was pervious in its course to the part where the ligature had been made on the femoral trunk; there it was plugged up by a small coagulum, beyond which it was impervious. The opening into the sac was on the

posterior part, and was one inch in length. The upper portion of the sac occupied a part of the cavity of the pelvis, and by its pressure prevented the branches of the internal iliac artery from supplying the thigh with blood."

"The coagulum in contact with the sac was the same as is usually met with in large aneurismal tumours; with that, there were innumerable thin, firm laminæ, and the innermost portion was in the state of jelly.

"It is a circumstance which could not have been foreseen, but one highly satisfactory to myself, that had I attempted to tie the artery *above* the formation of the aneurismal sac, I must have failed, since the sac extended higher than the division of the iliac artery into the external and internal, so that the external branch could not have been secured without wounding the sac, which would have proved fatal; and in the space above, between the division into the two iliacs, and the bifurcation of the aorta, there was an ossification an inch long; so that if the artery had been secured there, when the ligature separated, the patient must have bled to death. It may be said, that I might have taken up the aorta above the bifurcation; but I have made up my mind to let those diseases that require tying the aorta, which come under my care, take their course¹."

This new and ingenious mode of treating aneurism, by causing the coagulation of the fluid blood contained within the sac, and which was first suggested by Monteggia, of Milan, may be ultimately found of the highest practical importance, and may perhaps lead to the discovery of some safe as well as effectual means of obliterating an aneurismal sac—more easily than by the application of heat, or by any of those surgical proceedings which are usually resorted to for the cure of this formidable disease. It appears to me that the fluid blood contained within an aneurism might be coagulated with safety, by injecting into the sac a proper quantity of one of those substances which produce the instantaneous coagulation of blood that has been just removed from a living animal. Of these substances, perhaps there is no one which would be better adapted for this purpose than *acetic acid*, a small quantity of which is known to coagulate a very considerable quantity of blood. Vinegar could be very easily injected into the sac of an aneurism with Anel's syringe, a puncture having been previously made into the sac with a needle; and it might be advisable to arrest the circulation through the diseased artery, previously to such an operation, by an adequate compression of the vessel either on the capillary or cardiac side of the tumour. If the blood within an aneurismal sac could be thus coagulated, its curative effects might be reasonably supposed to proceed in the same manner, as if the coagulation of the blood had been effected by obstructing the circulation through the vessel by the application of a ligature.

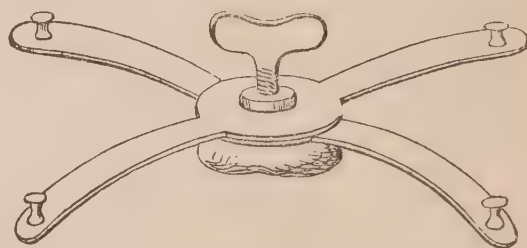
¹ On the Coagulation by Heat of the Fluid in an Aneurismal Tumour.—*Phil. Trans.* 1826.

It has also been proposed to coagulate the blood within an aneurism, by conducting a galvanic stream along needles introduced into the sac. (*Phillips, Pravaz.*)

Compression.—When local and general means have failed, or when from any cause they have been found inapplicable to the treatment of an aneurism, the next resource of art is to effect the consolidation of the tumour by the application of pressure, or by placing a ligature on the diseased vessel. The records of surgery afford many proofs of external aneurisms having been cured by compression, and the compression has been applied either on the tumour itself,—upon the diseased vessel on the cardiac,—or on the capillary side of the tumour, or on the whole of the limb wherein the aneurism is situated.

Various contrivances have been made use of in order to produce the necessary degree of pressure on an aneurismal tumour, but the objection to most of them is the great pain which their long-continued pressure creates. The instrument of *Seunfio* has been that most usually employed.

Fig. 63.



The instrument, represented in fig. 63, consists of two metal plates which cross one another and form four separate branches, at the extremity of each of them is to be affixed a belt which is to be passed round the limb. Through the central plate a screw passes, to which is attached a pad; so that by turning the screw any degree of pressure can be made, the pad having been placed immediately above the artery.

Compression, under favourable circumstances, and when properly made, may be highly useful; for even should it fail in such instances, it will not only not have been in any way injurious, but it will have had such an effect on the collateral circulation as to render the success of the ligature more certain.

In selecting the point on which compression may be made, regard should be had to the points where the artery is most superficial, as well as where it may be pressed against a bone. Compression may be made on the axillary artery, behind the clavicle—on the femoral, where it passes over the pubis, or at the upper and inner part of the thigh,—on the brachial, against the humerus, &c.

In some persons, the effects of the pressure are such as to render perseverance in its use either impossible from the pain, numbness of the limb, and excoriations, &c., or unadvisable from the œdema which it may determine.

After a bandage has been applied moderately tight from one extremity of the limb to the other, a compress may then be placed upon the tumour, and with a common tourni-

quet surrounding the limb, any degree of pressure may be applied on the compress, the whole limb having been previously secured from the action of the instrument by a piece of board wider than the limb itself, placed on the opposite side to the tourniquet,—by which means the tumour alone will be compressed. (*Freer.*)

The compressor of Dupuytren, which is usually employed in France, consists of a semicircle of solid steel, having at one extremity a large concave cushion adapted to the posterior part of the limb opposite to the diseased artery, and at the other extremity there is a pad which can be brought near to the cushion or removed from it by means of a spiral spring and screw. The pad is to be applied upon the artery, so that by turning the screw the requisite degree of pressure is made, and is confined to the two opposing points of the limb on which the cushion or pad is placed. When the screw is tightened, the instrument may be employed either for making the necessary degree of compression on the tumour, or on the artery above, or below the aneurism, as may be deemed most advisable.

An easy mode of applying compression upon an aneurismal tumour may be accomplished, by spreading a layer of plaster of Paris on the surface of the tumour upon which a moderate degree of pressure is to be afterwards made with a bandage. Besides the pressure effected by the bandage, there is a certain degree of compression produced by the contraction which takes place in plaster of Paris during its consolidation: at intervals of a few days the plaster should be removed and a new coating applied. By this means, Mr. Bennett Lucas cured a popliteal aneurism, without causing the degree of pain which usually is created by the other modes of applying pressure.

Compression on the *capillary* side of the tumour has also been proposed, and the plan was once adopted in a case of inguinal aneurism, but the force of the pulsations in the tumour were increased to such a degree as to render this mode of treatment inadmissible. (*Vernet.*)

The most common mode of using pressure for the cure of an external aneurism is by the compression of the whole limb, and it is of importance to bear in mind that pressure thus employed, whilst it diminishes the momentum of the blood in the diseased artery, must not be carried to such a degree as to interrupt the circulation in the other arteries of the limb, or that of the veins and absorbents; and above all, in the nerves. Any undue pressure upon the arteries will be the means of preventing a sufficient quantity of arterial blood being circulated for the nourishment of the limb, and if the absorbents be compressed, and the venous circulation interrupted, the limb will become œdematous; and if pressure be made upon any of the nervous trunks, the pain will be so great as to render a continu-

ance of the practice inadmissible. This general compression of the limb is best effected by applying a roller firmly, but not tightly, commencing at the extremities of the toes and fingers, and extending it above the aneurismal tumour. But, before the compression is applied to the tumour a compress ought to be placed, not only upon the aneurism, but over the trajet of the diseased artery on its capillary side. The bandages may be kept moistened with astringent lotions, and the curative effects of this compression are to be assisted by the complete rest of the limb, the evacuating treatment, the horizontal posture, and all such means as diminish the force of the blood's circulation.

Compression, in whatever mode it may have been successfully applied, has been supposed to cure an aneurismal tumour when small and of recent formation, by causing the sides of the artery to come in contact, and thus obliterating the tumour; whereas, when an aneurism is of a large size, and of long standing, compression cures the disease either by obstructing the circulation in the diseased vessel, or by diminishing the force of the current of the blood in the tumour, and thus permitting the coagulation of the blood to proceed more rapidly.

In all cases of external aneurism, where there are no inflammatory symptoms or tenderness of the swelling, or where these have been completely subdued by local as well as general remedies, compression may then be considered as particularly applicable; but on the contrary, when the tumour is tender to the touch and accompanied with inflammation, any mode of using compression is highly improper; indeed, if employed under such circumstances, it will aggravate the disease which it is intended to remedy. Even under the most favourable circumstances, the cure of an external aneurism by compression will generally be found to be attended with many difficulties, and hence the number of cures which have been performed by this mode of treatment variously modified have been comparatively few, and the successful results, unfortunately so uncertain, have seldom been obtained without causing much suffering.

A certain degree of compression may, in some cases, be employed with great advantage to diminish the tension of the integuments, and may prolong the continuance of life by preventing the bursting of the tumour. For such a purpose an external aneurism may be covered over with strips of adhesive plaster, and these may be applied in such a manner as not only to form a protection to the parietes of the tumour by giving them additional thickness, but they may be applied so firmly, and cover the tumour in such a variety of directions, as even to diminish its bulk as well as to resist its further distension from the impetus of the blood.

OPERATIONS FOR ANEURISM.

By far the most certain mode of curing an

external aneurism, when it can be with propriety adopted, consists in obstructing the flow of blood in the tumour by applying a ligature on the diseased vessel. Until the time of Hunter, the operations for the cure of aneurism were not only extremely dangerous and uncertain in their results, but were only applicable to the disease in a few of the arteries of the body. One mode of operating consisted in removing the contents of an aneurism, and then applying the actual cautery or graduated compresses to the extremities of the artery in the sac, and retaining them in that position by adequate pressure with a bandage, until there was no longer any risk of hæmorrhage; the sac was afterwards filled up by the process of granulation. Another method employed by the older surgeons was, to make an incision into the aneurismal sac, remove the coagula of blood contained within it, and then endeavour to tie the bleeding extremities of the vessel with a ligature. These operations, independently of the great difficulty in their execution, gave rise to numerous bad consequences, which, in a great majority of cases, where they were performed, led to a fatal termination.

There are *three* different modes of operating now employed for the treatment of aneurism, and the choice of each method depends on the particular artery, or on the particular portion of the artery which has become aneurismal.

The *first* of these modes of operating, consists in completely obstructing the circulation, by placing a ligature on the diseased artery, between the aneurismal tumour and the heart, or on the *cardiac* side of the tumour. The *second* consists in obstructing the circulation through an aneurism, by placing a ligature on the diseased artery between the aneurism and the capillaries, or on the *distal* side of the tumour; whilst the *third* mode of operating consists in not completely obstructing the circulation of the blood within the sac, but in diminishing its impetus, by placing a ligature on one of the branches of the diseased artery on the capillary side of the tumour.

The object to be effected by these different operations is either to form a complete barrier to the circulation of the blood in the tumour, or to diminish the impetus of the circulation to such a degree as shall permit the blood within the sac to coagulate.

When by any of these proceedings the aneurismal sac becomes filled with a coagulum of red blood, a fibrinous concretion is subsequently formed, and in proportion as the fibrine is deposited, so is the coagulated blood absorbed; and the concreted fibrine in its turn is gradually diminished in quantity, the sides of the sac approximate and coalesce, and ultimately the aneurismal tumour is greatly reduced in bulk, and is converted into a firm, solid, fibrous knot.

The *first* mode of operating, or that which consists of applying a ligature on the trunk of the aneurismal artery on the *cardiac* side of

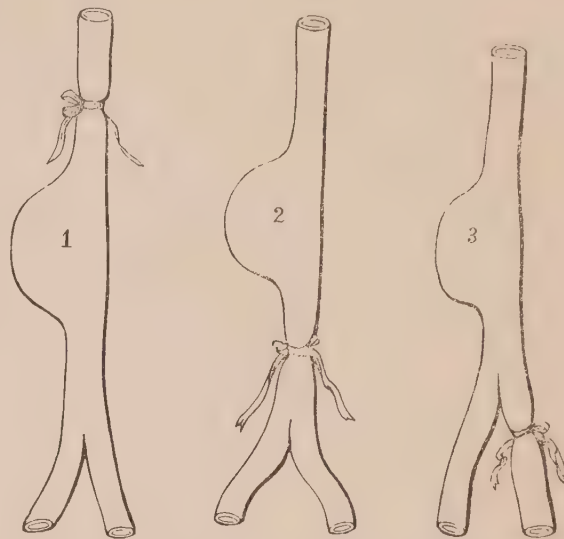
the tumour, was proposed and successfully adopted by John Hunter.

The *second* mode of operating, or the application of a ligature on the distal or capillary side of the tumour, was suggested but never executed by Brasdor.

The *third*, which consists in placing a ligature on one of the branches of the diseased artery on the capillary side of the tumour, was first suggested and executed by the author of this article.

These three different modes of operating are further explained in this diagram (fig. 64).

Fig. 64.



In the first, a ligature is placed on an arterial trunk on the cardiac side of an aneurismal tumour. In the second, is represented a ligature placed upon an arterial trunk on the distal or capillary side of an aneurism. And the third shows the ligature placed upon only one branch of the diseased artery.

We need only mention Anel's mode of operating as matter of history, as no British surgeon ever thinks of resorting to it at the present day. But if a surgeon should be so unfortunate as to open an aneurismal sac through mistake, the steps resorted to in this method will afford him his readiest resource against an immediate fatal termination. He should at once remove the coagula, and tie the mouths of the vessel, or plug up the cavity in the most effectual way he can. The cases of this kind that have been thus successfully treated, are by no means few in number. It may be here added, that in cases where the sac is large, nature will discharge the coagula by the formation of an eschar, the cavity, after suppurating, being filled up by granulations.

Hunter's mode of operating.—The operation for the cure of aneurism suggested by the ingenious Hunter, in 1785, has been justly considered as one of the greatest improvements which the history of surgery presents. That operation, consisting as I have already stated, in placing a ligature on the arterial trunk, between the aneurismal tumour and the heart, and at a distance from the aneurism, put an end, in a great degree, to the severity and danger attaching to the modes of operating which until that time had been

adopted for the cure of the disease. It was now no longer necessary to lay open the cavity of the aneurism, or to place a ligature on a portion of a vessel, perhaps unsound; the difficulties of securing the mouths of the denuded artery were altogether avoided, and the parts deprived of their due supply of blood, in consequence of the obliteration of the arterial trunk, are immediately and abundantly supplied by the anastomosing vessels. The innovation of Hunter was no rash or blind experiment: adhesion and absorption, principles which he had so ably developed, were the physiological resources on which he relied, and the application of a ligature on the sound part of an artery, and at a distance from the aneurismal tumour, may be considered as natural a result of his admirable labours, as the principle itself of healing wounds, *by the first intention*. Hunter, having established the soundness of his principle of operating for popliteal aneurism, by obliterating the superficial femoral artery, others were emboldened, more particularly some surgeons in this country, to adopt the same principle in other aneurismal arteries, and thus modern surgery has been lately enriched by a series of bold operations for the cure of aneurism, ligatures having been successively placed on arterial trunks of the first order in magnitude. Thus Abernethy placed a ligature on the carotid artery, and afterwards on the trunk of the external iliac in an aneurism of the inguinal artery; — Keate tied the subclavian artery for the cure of an axillary aneurism; — Mott, of New York, applied a ligature to the innominate; — and, finally, Cooper placed a ligature on the aorta itself.

Unaware of the restorative powers of the economy, and of the office which the inosculating branches of the arterial system are capable of performing when the circulation through a trunk is obstructed, the possibility of a limb being nourished, after the circulation through so large a vessel as the femoral artery became obstructed, had never been contemplated, until it was proposed by Hunter to place a ligature on that vessel for the cure of popliteal aneurism. This principle of operating was, indeed, more especially applicable to the treatment of an aneurism of the popliteal artery, because here the old operations must have been very difficult to execute; whereas the ligature could be placed with great facility on the superficial femoral artery, and at a considerable distance from the tumour. Accordingly, when this mode was employed in an aneurism of the popliteal artery, though Hunter made use, as we now know, of an unnecessary number of ligatures, without tightening any one of them in a secure manner, the new operation was successful, and has since been universally performed in all cases of external aneurism, where a ligature can be placed on the *cardiac* side of the tumour.

If a ligature be applied on an arterial trunk on the *cardiac* side of an aneurism, the first effect of the operation is to cause a complete stoppage of the circulation of the blood

within the sac—unless under some particular circumstances which will be hereafter mentioned. The blood then becomes stagnated, its coagulation readily takes place, and not only does the blood contained in the artery between the ligature and the tumour, and that contained within the tumour itself, undergo this change, but likewise the portion which is contained between the tumour and the first inosculating branch on the capillary side of the aneurism is coagulated. The circulation of the blood within the tumour having ceased, and its contents having coagulated, the progress of the disease is now arrested, and the tumour, in place of increasing, diminishes in bulk, and the whole of the coagulated blood is absorbed. A concretion of fibrine is afterwards formed within the sac and obstructed portion of the artery, the sides of the sac as well as those of the vessel gradually coalesce, and ultimately their cavities are obliterated.

Whilst these changes are going on within the sac, important changes are also taking place in the inosculating or anastomosing vessels. No sooner is the ligature placed on the arterial trunk than an immediate alteration takes place in the current of the blood. The increased impulse which is necessarily given to the heart's action, from the additional stimulus it receives by the increase in the quantity of its arterial blood, in consequence of the supply to a large trunk being obstructed, will assist in propelling the blood with greater vigour into the inosculating branches, so that they are at once enabled to fulfil the offices of the obstructed vessel, and abundantly to supply the limb with blood.

I have stated that the defective supply of blood in a limb, caused by the obstruction of an arterial trunk from the application of a ligature, is *immediately* balanced by the enlargement of the anastomosing vessels. That an increase in the size of the inosculating branches takes place as I have already stated, at least, to a certain extent, almost instantly after the trunk has been obstructed, is proved by an interesting circumstance, which I had first an opportunity of observing in a child on whom I placed a ligature on the external carotid artery. Immediately after the operation, the branches of the temporal and occipital arteries of the opposite side of the head could be distinguished through the delicate integuments, enlarging, becoming tortuous, and apparently circulating their contents with additional vigour.

To fulfil the office of a large arterial trunk, I have also mentioned that many anastomosing arteries appear at first to lend their assistance, but, sooner or later, the function of the obstructed vessel is performed by a very few inosculating branches, these acquiring a larger and larger size in proportion to the diminution in their number. The dissections of limbs, on the main arteries of which ligatures had been placed at different periods before death, point out those changes in the anastomosing vessels, and how the new channels become gradually diminished in number.

In one case, where the limb had been amputated some years after the femoral artery had been tied for a popliteal aneurism, an artery was found of apparently equal magnitude, and in the site of the original vessel. On examining the inferior extremity of a subject in the dissecting-room, of which no previous history was known, about three inches of the superficial femoral artery was obliterated, being converted into a ligamentous cord, in which there was no trace of a canal. The place of this artery was chiefly supplied by one of the branches of the profunda, the others not being much increased. This branch was equal in size to the superficial femoral in the opposite limb, and in the lower part of the thigh had nearly the same course with the remains of the superficial femoral, excepting that it did not pass through the sheath formed for the superficial femoral by the adductor longus and vastus internus muscles¹.

When the Hunterian operation for the cure of aneurism was first contemplated, it was undertaken on the principle that it would be followed by a *complete* stoppage of the circulation of the blood in the tumour. In some of the cases of popliteal aneurism, however, which were operated on by Hunter himself, and related by Home in the *Transactions of the Society for the Improvement of Medical and Chirurgical Knowledge*, it is stated that the tumour in the ham continued to pulsate for a considerable time after the ligature had been placed on the superficial femoral artery; and the conclusion he drew from that fact was, "that simply taking off the force of the circulation from the aneurismal artery is sufficient to effect a cure of the disease, or at least to put a stop to its progress, and to leave the parts in a situation from which the actions of the animal economy are capable of restoring them to their natural state."

Subsequent observations have shown, that the circulation in an aneurismal tumour may be continued, after the trunk has been tied, in two ways;—the one, in consequence of a branch or branches passing from that portion of the vessel situated between the ligature and the heart continuing open and communicating by anastomosis with other trunks; the other, by branches coming off from the artery at the distal side of the tumour, which branches anastomose with other trunks. But in whatever mode the circulation may have been kept up in the sac, the diminution in its force caused by tying the diseased trunk is sooner or later sufficient to insure the ultimate consolidation of the aneurismal tumour, except, as I have already stated, in a very few cases, wherein, in con-

sequence of some unusual distribution of the arteries the current of blood in the aneurism continues to such a degree as not to permit either the coagulation of the blood, or the formation of a fibrinous concretion sufficient for that purpose.

Fig. 65, presents an anomalous distribution of the femoral artery; *a* is the profunda; *b* and *c* two branches, into which the femoral artery is divided; on one of which a ligature was placed at *d*; *e* and *f* is the aneurismal tumour of the popliteal artery.

Brasdor's mode of operating.—Those aneurismal swellings which were so situated that the knife of the surgeon could not reach the artery between the tumour and the heart, being still, however, considered incurable, Brasdor, a professor of the ancient school of surgery, in Paris, was led to propose a mode of operating which he conceived might be applicable to some of those cases where the Hunterian operation was impracticable. The operation suggested by Brasdor was to place the ligature on an aneurismal artery upon the *capillary*, in place of the *cardiac* side of the tumour, in cases where no branch would intervene between the ligature and the sac. Dessault was in the habit of mentioning this proposal in his public lectures, and stated it as his opinion, that in a case of aneurism, where the position of the tumour was such as to render the Hunterian operation impracticable, Brasdor's proposal might be worthy of trial. But neither this justly celebrated surgeon, nor Brasdor himself, ever embraced an opportunity of performing it; and it was Deschamps, their contemporary, who first executed this new operation, though it was undertaken by him under the most unfavourable circumstances.

"A man sixty years of age had, in the superior part of his thigh, an aneurism seventeen inches in circumference, and there was not above a finger's breadth between the tumour and Poupart's ligament. Deschamps proposed to put a ligature on the artery on the capillary side of the tumour, hoping that the stagnation of the blood would cause its coagulation. The operation was performed, but was tedious and difficult on account of the pulsations of the artery not being distinguished. The progress of the tumour, which had been very marked immediately previous to the operation, increased so much after it, that upon the fourth day its rupture appeared at hand. It was then decided to adopt a second operation, and to tie the artery according to the ordinary method, notwithstanding all the considerations which had formerly prevented its being done. Compression was made against the pubes; and after opening the aneurismal sac, two ligatures were placed, one above and the other below the opening in the artery; the hæmorrhage was very great during the operation, and the patient died in eight hours."

Sir Astley Cooper was the next who made trial of this operation of Brasdor's, in a case of aneurism of the external iliac artery, which extended into the abdomen so high as to ren-

Fig. 65.



¹ On Aneurism, by James Wardrop.

der it impracticable to tie the vessel on the *cardiac* side of the tumour. A ligature was, therefore, placed on the common trunk of the femoral artery between the origins of the epigastric arteries and the profunda. The pulsation of the tumour continued, but its bulk did not increase after the operation. On the contrary, it diminished so much that it was conceived if it continued to diminish it might then have been possible to have tied the internal iliac artery on the *cardiac* side of the tumour. The aneurism, however, burst, and the patient died in consequence of an extravasation of blood in the adjacent cellular membrane.

These two were the only cases during a period of more than forty years, in which this mode of operating for aneurism had been adopted; and from the unfortunate results with which they were followed, the operation of Brasdor fell into disrepute, and an attempt was even made to turn it into ridicule.

"I cannot conceive," says Burns, "a more futile idea than to suppose that such an operation could possibly tend to prevent the growth of an aneurismal sac: one might readily believe that it may, by preventing the blood from passing freely through the tumour, cause it to enlarge more rapidly than before. That it would occasion a firm coagulum of the contents of the aneurism, and consequently enlargement of the anastomosing branches; a diversion of blood from the tumour is what one would hardly expect, and least of all would any one imagine, that Dessault would have been the projector of such a doctrine, and Deschamps the first to put it to the test of experiment. In doing this, the latter had no reason to boast of his dexterity, nor could he say more of his success. Indeed, all circumstances considered, there is no point in the treatment of aneurism, which should be more decidedly reprobated than this: it is absurd in theory, and experience proves that it is ruinous in practice."

Opposed, however, to this opinion, Hodgson, in his Treatise on the Diseases of the Arteries, a work which has been justly esteemed one of the most useful contributions to modern surgery, advanced a very different opinion of the proposal of Brasdor. "From these observations," remarks that learned writer, "I think we may conclude that the effect of tying an artery immediately below (on the capillary side) an aneurism, in a case where no branches originate from the sac, or from the artery between the ligature and the tumour has not hitherto been determined by experience. The termination of the two cases in which this practice has been tried by no means destroys the probability of a happy result under other circumstances. There is strong reason to believe, that if no branch originated from the aneurism, or from the artery below the aneurism, the blood would coagulate in the tumour, and that a cure would be accomplished by the absorption of this coagulum and the subsequent contraction

of the sac. The principle upon which a cure is expected to follow this mode of operating is the same as that upon which varicose veins are cured by tying the superior part of the vessel. The obstructed blood coagulates in the dilated vein; the coagulum is absorbed; the cyst contracts; and the disease is cured."

All speculation on the effect of Brasdor's operation was, however, set at rest, a favourable opportunity having occurred to myself in 1825, of performing an operation on this principle, in a case of Carotid aneurism¹. A female, seventy-five years of age, having been for three months afflicted with anomalous pains in the neck, and great difficulty in respiration; after a violent fit of coughing she perceived a swelling on the right side of her neck, a little above the clavicle. The tumour had all the characters of a diffused aneurism of the carotid artery, and had become so large that it was quite impracticable to tie the vessel on the *cardiac* side of the tumour, so closely did it come in contact with the clavicle. The tumour continued to increase, and on the eleventh day after it was first observed it had acquired a formidable aspect, the skin covering the scapular portion having become very red and painful, the pulsation, which was very strong throughout the whole swelling, being here particularly so; the parietes feeling extremely thin, and appearing as if ready to give way.

The patient's life being in the most imminent danger, it forcibly struck me that it might be expedient to tie the carotid artery on the *capillary* side of the tumour. There were circumstances which made this case particularly favourable for resorting to such a measure; the aneurism had been but recently formed; the patient, though far advanced in years, was in all other respects healthy. Besides, the diseased artery was most favourable for the trial of Brasdor's operation, no branches being sent off from the common carotid until it divides into the external and internal, the process of coagulation would not be interrupted by the circulation through any collateral branch in immediate contiguity with the aneurism. The operation also appeared practicable in this instance, as the aneurism, though large, still left sufficient space for the application of a ligature between the tumour and the division of the artery.

There was no particular difficulty in reaching the artery, but what might have been anticipated from its great depth, from the necessary limits of the incision, and from the numerous large veins which were to be avoided, particularly one branch that extended across the middle of the incision to the internal jugular. The vessel appearing to be healthy, one ligature was firmly tied round it, as close to the tumour as the incision would admit; and the lips of the wound were

¹ Case of Carotid Aneurism, successfully treated by tying the Artery beyond the Tumour, by James Wardrop, Trans. of Med. Chir. Society, 1825.

stitched together. The aneurismal tumour itself was covered with adhesive plaster in order to protect the tender skin, and at the same time to keep up a certain degree of pressure; as I expected that the resistance to the circulation which the ligature would necessarily occasion, might, for a short while at least after its application be followed by an increase in the size of the tumour. Instead of which there was an immediate *diminution* of its bulk, which was marked by a considerable corrugation of the skin at the base as well as a decrease in its redness. The patient passed the night after more comfortably than that previous to the operation.

A progressive diminution in the bulk of the aneurism, and in the strength of its pulsations took place, so that on the fourth day after the operation it seemed to have diminished nearly one-third; the upper and tracheal portion had lost all pulsation, and only the scapular portion retained an obscure undulatory thrill. The integuments, which had lost their redness, now became more inflamed, and during the fifth and sixth days there was a distinct increase in the size of the tumour, and it pulsated more strongly, which seemed partly owing to several severe fits of coughing. This apparently unfavourable change was, however, followed by a decided amendment; for on the eighth day after the operation the swelling again began to diminish, and the pulsation became more obscure, so that on the fourteenth day it was not much larger than half its bulk at the time of the operation. No pulsation could be detected in any portion of it, and merely a slight vibration was perceptible in some parts which seemed to be produced by the pulsations of the contiguous vessels, which were now enlarged, particularly the inferior thyroid artery.

The redness of the skin, however, continued to increase, and that of the scapular portion of the tumour to become more and more of a purple colour, till, at last, ulceration commenced on its most prominent part. Several considerable-sized portions of coagulated blood were now discharged along with some healthy pus through the ulcerated opening; and on the twentieth day after the operation the ulceration of the integuments had closed, and nothing of the tumour remained, but some wrinkling of the skin, and a considerable degree of thickening of those parts on which the base of the tumour had rested. These symptoms continued to diminish, and at the end of the fifth week from the time of the operation the neck had nearly assumed its natural form, a slight degree of inequality only remaining: the ligature had come away, and the patient's general health, on the management of which the greatest care had been bestowed, was now completely re-established. This patient visited me in perfect health four years after the operation.

Since that period, Brasdor's mode of operating has been adopted by Bush, Lambert, and Montgomery, in cases of carotid aneu-

rism, and the result of their operations has not only proved the soundness and practical utility of the principle, but has made us acquainted with some remarkable changes which take place in an aneurismal tumour when a ligature is applied on the trunk of an artery at the *distal* side of an aneurism, and that no branch intervenes between the ligature and the sac,—phenomena which, in many respects, are quite different from what had generally been supposed as likely to take place, from any previous reasoning on the subject.

Had, indeed, the principle on which this operation was suggested been strictly correct, or were it indispensable for the cure of an aneurism by Brasdor's mode of operating, that no branches should originate either from the sac or between the ligature and the sac, it is evident that practical utility must have been very limited, aneurisms being seldom met with in a situation where this mode of operating could be employed. The carotid artery is perhaps the only vessel in which an aneurism could occur wherein Brasdor's suggestion could be fairly adopted,—an aneurism which not only is very rarely met with, but which had been considered of so formidable a character as to have been supposed beyond the reach of surgery until many years after Brasdor's proposal had been made.

When, as in Hunter's operation, a ligature is applied on an artery between the aneurism and the heart, or on the *cardiac* side of the tumour, the whole mass of blood in that part of the vessel between the ligature and the tumour, as well as the blood which is contained in the tumour itself must cease to circulate, and the ligature has to make a sufficient resistance to withstand the impulse of the blood in the cardiac portion of the vessel, until the internal clot and the adhesions of the sides of the artery at the point of ligation are sufficient to prevent hæmorrhage. The blood in the tumour itself then coagulates, and the subsequent diminution, and the consolidation of the aneurism afterwards, take place more or less quickly. Now let us consider what happens if a ligature be placed on the capillary or *distal* side of an aneurism, and in a case where no branch either passes directly into the tumour, or comes off from the trunk of the artery between the tumour and the ligature. No sooner is the ligature applied in such a case, and the usual course of the blood's circulation interrupted, than the anastomosing vessels dilate, and perform the function of the obstructed arterial trunk, in like manner as takes place after the Hunterian operation. It might indeed have been expected, that whenever the ligature was tied, the resistance thus given to the circulation would cause an increased effort in the vessel to propel its contents, not only against the point of resistance caused by the ligature, but likewise against the parietes of the sac. Any increase of impetus in the blood, however, can only continue a

very short time ; for as I have previously pointed out, when an artery is either divided or tied, anastomosing branches freely carry on the circulation ; and the cases in which the operation of Brasdor has been performed, where the tumour was large, prove that instead of increasing in size after the artery was tied on its distal side, the swelling in a few minutes diminished considerably—a circumstance which was satisfactorily ascertained by the skin which covered it, and which was tense and ready to burst before the operation, immediately forming into wrinkles as soon as the ligature was applied upon the artery. If the current of the blood be thus turned into a new channel, the aneurismal sac, as well as the portion of the artery extending between the aneurism and the ligature, will now be in a passive state ; and though the blood may continue, for a certain time, to be influenced by the impulse of the circulation which is carried on in that part of the vessel which passes into the tumour, still its current must become, not only irregular, but extremely languid—a condition which we know will admit of its being speedily coagulated. Whenever the coagulation of the blood in an aneurism does take place, then the cure of the disease may be said to be accomplished ; a fibrinous concretion is deposited, and the sac contracts ; or if the quantity of coagulated blood be very great, some clots may be discharged through the skin by a process of suppuration, the fibrine formed within the sac will be ultimately absorbed, and the aneurism consolidated.

Let us next consider the difference in the condition of the blood which is contained in an aneurism, when a ligature has been placed on the cardiac, as compared with that in which it is found when a ligature has been placed on the distal or *capillary* side of the tumour. If the ligature be applied on the cardiac side of an aneurism, as the blood cannot be propelled from the sac through the capillaries of the artery, which is obstructed by the ligature, it must remain there until it be either absorbed or evacuated by a process of inflammation and ulceration of the tumour and its adjacent integuments. But when the ligature is placed upon the capillary side of an aneurism, there is an immediate diminution in the bulk of the tumour, the fluid blood within it can find, under such circumstances, a ready exit into the arterial trunk, along which it had passed, and thus, again, it gets into the circulation, in place of, as in the other case, having no exit but through the capillaries ; and no more blood can be afterwards impelled into the tumour, a new channel for carrying on the circulation being immediately established.

This diminution in the bulk of the aneurismal tumour, a point so clearly established by a reference to all the cases wherein Brasdor's operation has been employed, is one of great importance, and ought to be taken into consideration in operating for aneurism in those cases where the ligature, according to the choice of the surgeon, may be applied, either

on the cardiac or capillary side of the tumour. In two cases of carotid aneurism, where the ligature was placed on the cardiac side of the sac, both patients died from an increase in the size of the tumour, which took place after the operation. It would therefore seem, that when the ligature is placed on the *cardiac* side of an aneurism, the contents of the sac are not diminished, but a congestion takes place of all the blood which it may contain at the time of the operation ; whereas, when a ligature is applied on the *capillary* or distal side of the sac, an immediate and permanent diminution is produced in the bulk of the tumour. In the cases of carotid aneurism, where the ligatures were placed on the *cardiac* side of the sac, the cause of death was attributed "to the inflammation of the aneurismal sac and parts adjacent, by which the size of the tumour became increased, so as to press on the pharynx and prevent deglutition, and upon the larynx so as to excite violent fits of coughing, and ultimately to impede respiration." (*A. Cooper.*) This congestion and subsequent inflammation of the sac are therefore to be considered as serious evils attending the Hunterian operation,—evils which are in a great degree avoided when the ligature is placed on the capillary side of the tumour.

It is not one of the least important advantages of Brasdor's mode of operating, that the risk of *secondary hæmorrhage* will be less than when the operation is performed according to the method of Hunter. The ligature, it is clear, has to fulfil a very different office, when placed on the capillary side of an aneurism, from that which is required of it when placed between the aneurism and the heart. Instead of stemming a strong current of the blood, until an internal clot is formed, and the sides of the artery adhere, the ligature, when placed on the capillary side of the sac, has to make resistance to the current of the blood during a few minutes only, for the blood receiving a new direction, the circulation in the tumour becomes extremely languid immediately after the ligature is applied, as is proved by the instantaneous diminution in the bulk of the aneurismal tumour. The blood, too, which is contained in that portion of the artery between the ligature and the sac, must also stagnate, and soon coagulate, thus forming a complete barrier to all future circulation, and rendering any further assistance from the ligature unnecessary. So much must this be the case, that were there any useful purpose to be served by it, the *temporary* ligature would be particularly applicable in Brasdor's operation.

In one of the cases of carotid aneurism, where Brasdor's mode of operating was adopted, and it is the only one which proved unsuccessful, the patient was lost from hæmorrhage ; but it is important to remark, that the blood, in this instance, escaped from the *capillary*, and not from the cardiac orifice of the artery ; the aneurismal sac, and the portion of artery

between the sac, and the ligature being filled with concremented fibrine, and impervious (fig. 66).

Fig. 66.



All these changes in an aneurismal artery, on which a ligature has been placed on the capillary side of the aneurism, are explained in this figure. From the arch of the aorta (*a*) is seen coming off the left carotid artery (*b*), the innominate laid open (*d*), a portion of the right subclavian (*e*), and above it the aneurismal sac (*f*) of the carotid is laid open, in which there is a mass of firm coagulum, filling up completely the cardiac orifice of the sac (*g*), and the parietes of the sac itself are much thickened with concremented fibrine: (*j*) and (*h*) are two orifices of the artery formed by the ulceration of the ligature; the cardiac orifice (*h*) being filled with a coagulum, whilst the capillary orifice (*j*) remained quite pervious.

The ligature, therefore, in this mode of operating for a carotid, or any other aneurism, where no branch comes off between the sac and point of ligation, has a double office to perform, viz. to prevent the escape of blood, both from the cardiac and capillary orifices of the artery, and it is evident that the risk of hæmorrhage from the cardiac orifice, which is so considerable in Hunter's operation, is by no means so great in that of Brasdor's. But independently of this, the fact itself, that hæmorrhage may take place from the capillary orifice in the vessel, whether the ligature be applied on the cardiac or on the distal side of the aneurism, illustrates the change produced in the state of the circulation of the blood when an arterial canal is obstructed, and it also points out that there is a retrograde motion of the blood in the portion of artery on the capillary side of a ligature, the branches of the obstructed trunk acquiring a power to transmit blood in a direction opposite to its natural current,—the re-

trograde motion of the blood being somewhat analogous to the anti-peristaltic motion of the alimentary canal. Indeed, the circumstance that there sometimes is a retrograde motion of the blood in an artery on the capillary side of a ligature deserves consideration in determining the mode of applying ligatures, there being often greater danger of secondary hæmorrhage from the capillary than from the cardiac orifice of the artery at the point of ligation.

Nature employs the same process to prevent hæmorrhage from both orifices, and therefore it is requisite that a sufficient portion of the vessel should intervene between the ligature and first ramification of the artery to permit the formation of an internal clot on both sides of the ligature.

The author's mode of operating.—When speaking generally of the different operations which are employed for the cure of aneurism, I mentioned that besides the two modes of operating, those of Hunter and Brasdor, there was a *third*, which was suggested and executed by myself in 1827; a mode which is more particularly applicable to the treatment of aneurisms so situated that neither the operation of Hunter nor that of Brasdor can be performed¹. The operation, as has been briefly stated, consists in placing a ligature on one of the branches of the diseased artery instead of on the trunk of the vessel itself. I shall here explain the principle of this operation, as well as the circumstance which led me to propose it,—giving likewise an account of the cases in which it has been performed.

Though it had been satisfactorily shown, both from certain symptoms which existed during life as well as by an examination of the diseased parts after death, that a popliteal aneurism could be cured even when subsequently to the operation of tying the superficial femoral artery a stream of blood continued to flow through the sac, still a knowledge of that circumstance did not lead to any practical result, or any alteration in the Hunterian mode of operating. The fact of the subsidence of an aneurismal swelling, and in some instances even of its ultimate consolidation, were sufficient to warrant the general adoption of Hunter's plan.

The process of a "spontaneous cure," or the means which the economy employs to prevent the bursting of an aneurism, might have, indeed, afforded sufficient proof that coagulable lymph, or the fibrine of the blood, can be deposited within the sac of an aneurism without any very great languor in the circulation, or diminution in the momentum of the blood. Unless, perhaps, in some very small aneurisms, wherein the internal and middle coats of the artery remain entire, in no case do we ever find the sac of an aneurism without a concretion of laminated fibrine.

The circumstance that an aneurism could

¹ On Aneurism, with an Account of a new Operation for its Cure, by James Wardrop, 1828.

be cured by the Hunterian method of operating, notwithstanding a languid circulation had continued in the sac, along with the pathological facts here mentioned, was not, however, taken into consideration by those surgeons who had advocated the propriety of adopting Brasdor's method; on the contrary, they imagined that a ligature could not be successfully applied upon an artery on the distal side of an aneurism, if any branch intervened between the ligature and the sac; and thus assuming that the mode by which a ligature placed on an aneurismal artery cured the disease, could only be by causing a stagnation and subsequent coagulation of blood within the sac, they naturally inferred that a stream of blood, however small, through the tumour, would prevent such coagulation taking place. Alluding to the case operated upon by Deschamps, and the cause of its failure, Hodgson observes:—

“If a stream continued to pass through the aneurism into branches which originated below it, the blood contained in the tumour was *not at rest*, and consequently did not coagulate; a cure *could not*, therefore, be expected to ensue on the principle which led to the performance of the operation.” And again, “It must be acknowledged, however, that it will be almost impossible in any case to ascertain that *no branch* arises from the sac, which by continuing the circulation through the latter, may defeat the objects of the operation.”

From the important pathological fact, that in the processes which are employed by Nature for effecting the “spontaneous cure” of an aneurism, and likewise from the circumstance, that in some cases of popliteal aneurism, where the Hunterian operation had been performed, a complete stoppage of the circulation of the blood within the tumour had not been required, it appeared to me a legitimate conclusion,—that the progress of an aneurism might be arrested, or even the tumour consolidated, by placing a ligature *on one of the branches* of a diseased trunk.

It being admitted that a diminution in the force of the circulation of the blood, through an aneurismal sac, was sufficient to cure the disease, the important question still remained to be determined,—to what degree is it required to diminish the momentum of the circulation through an aneurism in order to permit a fibrinous concretion to be formed within the sac?

Here it is of importance to observe the difference between a coagulum of red blood and the concrete fibrine formed within an aneurismal sac, as the formation of each must be the result of a very different process. The word *coagulum*, as I have already noticed when speaking of the anatomical characters of aneurism, has been commonly employed to express both coagulated red blood and concreted fibrine, and, therefore, when we speak of the artificial means of effecting a coagulation of the contents of an aneurism, we ought

to discriminate whether such means are required to promote the formation of a fibrinous concretion, or merely to produce a coagulation of the red blood within the sac. According to the principles of operating, both of Hunter and Brasdor, their operations were adopted with the conviction—that by putting a complete stop to the circulation in the tumour, there would be not only a stagnation but a coagulation of the red blood within the sac. It is quite evident, however, that in those cases of popliteal aneurism, where a curative process was established by tying the superficial femoral artery, and in which a stream of blood still continued to pass through the sac, no coagulum of red blood would be formed, but the parietes of the sac would be thickened, or its cavity ultimately obliterated, by the deposition of fibrine. It is equally clear, that in all those aneurisms in which a “spontaneous cure” has been effected, or where an effort has been made by the economy to prevent the rupture of an aneurismal sac by the addition of new matter to its parietes, that new matter is not coagulated red blood, but invariably consists of a succession of laminæ of organized concreted fibrine.

That a very moderate degree of diminution in the impetus of the circulation in an aneurismal sac is sufficient to allow fibrine to be effused within its parietes, seemed to me proved from the pathological facts which have been pointed out, when speaking of the spontaneous cure of the disease, and more especially from having observed, in an aneurism of the innominate, that Nature had arrested the progress of the tumour, by obliterating the carotid artery.

In examining, likewise, the cases where a “spontaneous cure” had taken place by a barrier to the circulation of the blood in the sac being formed by an obstruction in the vessel on the capillary side of the aneurism, it was evident that a process of coagulation in the aneurismal sac must have commenced at a time when the momentum of the blood within the sac could have only been diminished in a very slight degree, no greater change having taken place in the force of the circulation than might be supposed to be the effect of an enlargement of the arterial tube at the diseased part. Neither could it be supposed that the arteries which were obliterated in the cases alluded to, had undergone any thing like a sudden obstruction; on the contrary, whatever was the process, the arterial canals appeared to have been gradually obstructed; this being indicated by the slow diminution in the force of their pulsation during life. But besides the phenomena already stated, no circumstance appeared more conclusive in pointing out this diminution of the blood's momentum to have been very slight, than laminated fibrinous concretions being often found within aneurismal sacs of so small a size, that the change in the velocity of the circulation within them must have been very inconsiderable.

From the knowledge of all these important pathological facts, therefore, I was led to conceive the probability of being able to cure an aneurism by placing a ligature upon *one of the branches* of the diseased artery.

A case of Aneurism of the Innominata soon occurred, which afforded a favourable opportunity of testing this new mode of operating. Nature had already instituted a curative process in this case, the circulation in the right carotid artery having diminished to such a degree that its pulsations were scarcely perceptible. This circumstance alone not being sufficient to put a stop to the increase of the bulk of the aneurism, I thought it probable that, by placing a ligature on the subclavian artery, I should be strictly imitating the process which Nature herself had commenced, and that by thus further diminishing the force of the circulation, a coagulum would be allowed to form within the sac. A portion of blood, however, would necessarily continue to pass along the innominata, even after the subclavian artery was tied, and a stream would continue to flow through the sac, and supply those branches of the subclavian on the cardiac side of the ligature, it being all but impracticable to place a ligature on the subclavian until it emerges from between the scaleni muscles; such, however, I anticipated, would be the diminution in the impetus of the blood through the sac, that the process of coagulation and consolidation of the tumour would not only proceed, and its future increase be prevented, but that even a permanent obliteration of the aneurismal cavity would be accomplished.

Fig. 67.



Fig. 67 is an aneurismal tumour of the arteria innominata, which by its pressure had obliterated the carotid artery; (a a a) the outline of the aneurism, comprehending nearly the whole length of the innominata; (b) the trunk of the innominata; (c) the subclavian, with its branches; and (d) the carotid laid open, its sides were compressed by the aneurism, but its canal remained pervious, except at its termination in the sac, where it was completely shut up by a thin delicate membrane, apparently a continuation of the membrane lining the sac.

An aneurism of the arteria innominata appeared to me, indeed, particularly suitable to make a trial of this principle of operating; and I was led to this opinion from having examined a case where the coats of the sac of an aneurism in that artery were thickened with fibrinous concretions, and in which the right carotid had been completely obstructed not only by the pressure of the tumour with which it was in close contact, but likewise by a delicate false membrane covering the orifice of the vessel where it arose from the sac; the effect of the obliteration of the carotid must in this case have been to diminish the circulation of blood through the aneurism at least one half, a diminution quite sufficient to cause that languor of the circulation necessary to permit of the formation of a coagulum within the sac. I had also met with a case where Nature had absolutely accomplished the consolidation of an aneurism of the innominata by closing up the subclavian as well as the carotid artery.

It therefore appeared to me that in the patient with aneurism of the innominata then under my care, and in whom the circulation through the carotid was already greatly diminished, if not altogether interrupted, to place a ligature on the subclavian would be a proceeding in strict imitation of the spontaneous process to which Nature resorted for the cure of aneurism of the arteria innominata in the case to which I have just alluded. It was also a matter of consideration as to this patient, that the tumour had been increasing so rapidly that her life was in imminent danger, and though I was apprehensive that the aorta was also implicated in the disease, yet the uncertainty in the diagnosis of such cases, and a knowledge of the fact that persons may live for many years with the aorta in a diseased condition, impressed me with the propriety of placing a ligature on the subclavian artery in this case. The operation itself was one of no great danger, and as there was no other means of prolonging life, I considered the trial of the measure justifiable.

In this case of Mrs. Denmark there was a pulsating swelling the size of a turkey-egg, whose base was situated under the clavicular edge of the sterno-mastoid muscle, and where the bellows' sound could be heard. She experienced severe pains, extending through the left side of the head and neck, and a disagreeable sensation of throbbing in the tumour. She had at times great difficulty of respiration, which increased on the slightest motion to such a degree as to produce a sense of impending suffocation; and her nights were very restless and disturbed, sleeping but for short periods, and being often obliged to get out of bed. Her countenance bespoke great anxiety, and her complexion was pale and sallow.

The disease had commenced, eleven months before, with difficulty of respiration, cough, and severe pains in the chest, head, and neck, which she considered to be rheumatic. About five months afterwards, she accidentally ob-

served, when washing her neck, a pulsating tumour above the sternum, which very slowly, but perceptibly, increased, and it was attended by violent and distressing throbbings. Small bleedings were then frequently had recourse to; she took digitalis, was kept on a low diet, and in a state of the most perfect quiet. This plan of treatment alleviated the severity of the symptoms, and seemed to stop the progress of the disease. The tumour, however, soon increased most rapidly in bulk, giving rise to great difficulty of respiration, cough, distressing sense of suffocation, and violent throbbing in the tumour and neck; the integuments covering the apex of the swelling had also become painful. Accordingly, on the sixth of July (1827), I performed the following operation:—

The arm was placed downwards and backwards, and the head turned to the left side. I found great advantage from placing a solid semicylindrical block of wood under the neck, for securing the head in a steady position. Two incisions were made through the integuments—one parallel to and immediately above the clavicle, fully four inches in length; and the other parallel with, and immediately above the edge, of the clavicular portion of the mastoid muscle. These two incisions met at an angle upon that muscle close to its insertion in the clavicle; the superior termination of the incision extended close to the external jugular vein, which was not endangered. Instead of first dissecting back the skin, then the platysma myoides, and the cervical fascia successively, I made the incision at once through these parts, safely guided in doing this by cutting down as deep as the fibres of the sterno-mastoid muscle. I was thus enabled, by one dissection, to raise a triangular flap composed of skin, platysma myoides, and fascia. By this method, the supra-clavicular space was distinctly exposed, and the numerous veins and arteries were only once divided. I allowed the bleeding of these, which was by no means profuse, to cease; and it was not necessary to tie any of the divided vessels. The remaining part of the operation was performed with a blunt-edged silver knife, and so trifling was the hæmorrhage, that every part concerned in the subsequent steps of the operation could be distinctly seen.

The fat which fills up the supra-clavicular cavity, in which the subclavian artery lies, was pushed aside, and the deep fascia which extends between the omo-hyoideus muscle, and the first rib, and which in this case was remarkably strong, was exposed. A single silk ligature of moderate thickness was tied round the vessel; the wound was closed up by a few stitches and adhesive plaster. The pulse at the wrist now ceased; no pulsation could be detected in the right carotid artery or its branches. There was an immediate relief in her breathing, which became free and tranquil; and this change was more striking, as during the preceding twenty-four hours she had suffered an unusual degree of suffocating

dyspnœa. The peculiar sensations which she complained of in her head were also removed. Although it could not be positively asserted that the tumour diminished, there was certainly no increase of its size, and the patient herself distinctly expressed, that she felt a decided diminution in the force of the beating; and this was confirmed by my own observation.

Twenty-four hours after the operation a very slight pulsation could be observed at the wrist, which continued without an increase of force; the temperature of the arm was not altered. The remarkable relief which she experienced in her breathing continued, as well as the diminution in the throbbing of the tumour, immediately after the operation; neither did the uneasy feelings in her head return. She also enjoyed very refreshing sleep, of which she had long been deprived. The anxious character of her countenance entirely subsided, and there only remained that appearance which belongs to a person who has undergone considerable depletion.

The operation was not followed by any febrile excitement; and, although the pulse continued rather more full and frequent than natural, the skin remained cool and moist, the tongue clean, and the bowels perfectly regular.

On the ninth day after the operation, a pulsation became perceptible in the *carotid artery*, which gave rise to much speculation. Some were inclined to consider it owing to the inosculation of the vessel with those of the opposite side, the blood thus arriving at the trunk from its extreme ramifications. This opinion seemed to be strengthened by the fact, that the pulsation was at first stronger in the temporal branch, than in the carotid itself. It seemed to me, however, more natural to account for this circumstance, by supposing that the aneurismal tumour, which formerly rose high in the neck, had, previous to the operation, compressed the carotid, and thus prevented the circulation of blood through it; and, that the swelling having now, by the effects of the ligature, become greatly diminished, the pressure had ceased, and a free course now existed for the trajet of the blood. Whatever explanation may appear the most likely, the occurrence itself could not be regretted, since the tumour having continued gradually to diminish, it tended only to prove more completely the truth of those principles which I advanced, and from a knowledge of which the operation was suggested; and although, had the vessel been altogether blocked up, the aneurismal tumour would by this time have completely disappeared, yet, even with the circulation of blood through the carotid, that event would in all probability ultimately arrive. Be that, however, as it may, the patient was brought from a state of great suffering, to one of comfort, bordering on health.

On the 22nd day, the ligature came away, and the wound healed; and one month sub-

sequent to the operation, Mrs. Denmark left London, with the view of establishing, through the influence of open air, gentle exercise, and milk diet, the more complete recovery of her health, which, from the time the operation was performed, had been gradually improving, so that at the period of her removal she had no complaint, except a great degree of weakness and emaciation, which, independently of the existence of the aneurism, might have been produced by the long confinement and rigid depletory treatment to which she had been subjected. The only symptoms of the original disease which still remained, were a considerable degree of difficulty of respiration, much aggravated by walking, and a slight, scarcely perceptible pulsating enlargement, immediately above the sterno-clavicular articulation.

The distressing cough, sense of impending suffocation, severe pains in the neck and shoulder, the constant head-ach, and the tumour, which at the time the ligature was applied to the artery had attained the size of a turkey-egg, had all now very nearly disappeared, the wound had healed, and indeed hardly a mark remained to point out the former existence of the aneurism.

In this condition she went to the country, and derived immediate advantage from the change. Her strength daily increased, the dyspnoea in a corresponding degree diminished, and her general appearance improved perceptibly to those around her. In the course of a very short time she was able to walk out into the open air, and the severity of the dyspnoea had now diminished so much, that she could ascend a staircase with comparative ease.

The pulsation of the right carotid artery was now distinct, though by no means so strong as that of the left. The radial artery of the right side was scarcely perceptible, while that of the left conveyed a peculiarly hard thrilling sensation. On application of the stethoscope to the thorax, the pulsations of the heart were found to be natural, but at the upper portion of the sternum, a slight impulse was perceived, as if arising from some considerable enlargement of the origin of the *arteria innominata*. This impulse was, however, scarcely to be discovered, except after the patient had been making some bodily exertion, or when her mind had been agitated, more especially by questions which excited a suspicion of the existence of any supposed danger. Her countenance had lost entirely that anxious expression which was formerly so remarkable; and indeed her whole appearance bespoke the enjoyment of tolerable, though feeble, health. She had been attacked, after exposure to cold, with a severe bronchitis, and a consequent return of the dyspnoea to a great degree, which rendered the abstraction of blood necessary; by means of which, and attention to diet, she regained a nearly perfect state of health. On her return to London, it was found that not a vestige of the aneurismal tumour remained, the disloca-

tion of the clavicle no longer existed, and all the distressing symptoms of her alarming disease had vanished.

Soon after, without any assignable cause, Mrs. Denmark was again attacked by a severe bronchitis, which, whether from the disorder arising from the state of the coats of the aorta increasing, or any impediment to the circulation of the blood which might exist from the closure of the subclavian artery, produced symptoms of an alarming character. The bronchitic affection having continued for two days, I found her labouring under a degree of dyspnoea so great, as entirely to prevent her lying down, and producing a most agonising sense of impending suffocation. She had a frequent cough, which was accompanied with copious expectoration of a frothy mucus; the pulse was about 130, and wiry; the skin was hot, and there was great febrile derangement, accompanied, towards midnight, with high delirium. She complained much of the sensation of impending suffocation, which was accompanied with a slight difficulty in deglutition. There was also present slight oedema of the feet. On examining the neck, no tumour could be found in the situation of the former aneurism, nor were the pulsations of the aorta and heart more strongly felt than before the occurrence of this severe attack, nor, indeed, did any symptom appear to indicate that the disease in the vascular system had increased. Under these circumstances she was largely bled, leeches were applied to the chest and feet, and she was kept constantly under the effects of nauseating doses of the tartrate of antimony. During the course of the next day, she was again twice largely bled, once cupped in the region of the sternum, and the action of the antimony was continued. From this treatment she experienced considerable relief; but during the course of the three succeeding days I found it necessary to repeat the venesection. She was now reduced to a very weak condition; but although the pulse had sunk nearer to the natural standard, and the febrile action had greatly subsided, yet she still experienced a remarkable degree of difficulty in breathing, accompanied with the feeling of suffocation, which had so alarmed her. The cough was still very frequent, and accompanied with more copious expectoration. She was, during the next week, kept extremely low, and again bled, after which she began to revive, and her difficulty of breathing became considerably relieved, but still it was so difficult that she was unable to lie down, and always slept propped up in bed.

She continued in a very weak and precarious state for several weeks, during which time the difficulty of respiration frequently increased to such a degree, as to render the abstraction of blood necessary. For two months she was unable to rise out of bed, and during all that time was affected with a greater degree of difficult respiration, cough, and expectoration, than she had ever ex-

perienced, except at the commencement of the attack. At this period, to such a state of weakness and emaciation had she been reduced, that a female friend, who came from a distance to see her, fainted the moment she beheld the altered condition of her person. She now, however, began gradually to recover, was able to sit out of bed, and her respiration became more free; but she was still unable to sleep in the horizontal position. During the whole period of this severe illness, no appearance of any pulsating swelling could be discovered in the site of the former aneurism, nor did the aorta or the heart betray any symptom of disease. It ought here to be observed, that from the time of her return from the country, to the commencement of this illness, she had not been bled; and perhaps the cessation of an evacuation, to which she had long been habituated, may have had some effect in producing the severe attack of bronchitis. I thought it therefore advisable, in order to prevent any recurrence of this complaint, to repeat the bleedings frequently, particularly as she was sensible that they always afforded her great relief.

It is of importance to observe, that from the commencement of my attendance on this patient, she had up to this period been bled above fifty times, to an extent at each operation seldom less than a pint of blood, and frequently to nearly double that quantity.

This treatment was persevered in for six weeks, and she regained her former appearance in a wonderful manner. The difficulty of respiration diminished greatly, so much so, that she could sleep in the natural position, and she was entirely free from the dreadful sensation of threatened suffocation. No tumour was now perceptible in the site of the former aneurism, but an unnatural feeling of hardness could be perceived at the root of the neck, immediately above the sternum, arising, no doubt, from a consolidation of the aneurismal tumour. The right carotid artery still pulsated, although not so strongly as the left; but its branch, the temporal artery, afforded no indication of the circulation of blood, and the right radial artery beat with about half the strength of the left. She suffered none of those pains in the regions of the neck, shoulders, and back; nor had she, for a long time, experienced any of the severe headaches which formerly gave her so much uneasiness, the œdema of the feet had entirely disappeared, and she was able to take exercise in the open air daily.

For some time after this period no change took place in Mrs. Denmark's condition; but she occasionally suffered from severe attacks of dyspnœa, which were generally relieved by blood-letting. In about three months, however, a swelling was perceived immediately above the sternum, and a tumour arose which, as it advanced, occupied the centre of the neck, and covered the inferior portion of the trachea. In the course of some months afterwards a second tumour made its appearance

in the site of the root of the right carotid artery, and extending up the right side of the neck. These two newly-formed swellings were so intermingled at their base with the firm and consolidated remains of the original aneurism, that the whole formed one formidable mass, the limits of which could not be ascertained by the touch, and could only be a matter of conjecture. Many opinions were hazarded as to the origin and precise site of this tumour; my own opinion, however, remained unaltered, and I now deliberated on the propriety of tying the right carotid artery. It must be recollected that when I first contemplated obliterating the subclavian artery in this case, I did so from the conviction that Nature had already obliterated the right carotid, that vessel having long ceased to pulsate, and although sufficient time had elapsed from the application of the ligature on the subclavian artery to allow the process of coagulation in the tumour, yet when the circulation through the right carotid was observed, on the ninth day after the operation, to be imperfectly restored, the occurrence was most unexpected; nevertheless, the aneurismal tumour continued to decrease, and its distressing symptoms to become alleviated.

However firmly I adhered to the original opinion I had formed of the seat of this aneurism, there were some surgeons in whose discrimination and judgment I placed great confidence, who were dubious of the precise site of the tumour. Such doubts, in a case of so difficult diagnosis, together with a consideration of the severity and danger of tying the carotid artery, even under the most favourable circumstances, were to me sufficient reasons for not performing that operation; I therefore endeavoured merely to mitigate the symptoms by a rigid system of depletion. The aneurism continued for some time to enlarge, after which very little alteration in the state of the tumour took place. Respiration and deglutition were both impaired, and there was a copious secretion of watery mucus from the bronchi. The patient's general health varied; she was sometimes comfortable and cheerful, at others, languid and feeble. About two months before her death general anasarca came on, and when it had increased so much as considerably to distend the integuments, the fluid drained off from an opening in the inferior extremity. During this period, she became considerably weaker, and was at last attacked with a violent diarrhœa; which, although checked soon after its accession, reduced her so much that she gradually became more and more exhausted, and expired twenty-three months from the time the operation was performed.

On examination after death, the bulk of the aneurismal swelling had not diminished. After removing the integument of the neck, the tumour was found to occupy the central space between the two sterno-mastoid muscles, and the sternal portions of each of these muscles lay over the sides of the tumour. The mass

may be said to have been composed of three divisions; one sternal, arising immediately above the sternum, another passed upwards along the trachea, and the third was the original portion of the aneurism which had become consolidated after the operation. These three masses had formed in conjunction a lobulated tumour larger than a turkey-egg. It adhered firmly to the sternum, and a portion of that bone was absorbed. The aneurismal tumour, as might have been expected from its bulk not having been diminished after death, felt like a firm fleshy mass. On laying it open longitudinally it appeared nearly solid. The coats of the sac presented the usual appearance observed in true aneurism, and the clavicular and tracheal portions of the sac were filled up with a firm fibrinous concretion, leaving a cavity only about the size of a walnut. On cutting into the innominate from the aorta the aneurism was found to have originally extended from the origin of the innominate to its bifurcation. Both the cardiac and distal orifices of the subclavian artery, where the ligature was applied, were contracted, and the sides of the vessel adhered together so firmly that a probe could not be passed further along the canal than to within about a quarter of an inch of the distal extremity of the divided vessel. The right carotid was pervious and quite healthy. The parietes of the heart were thinner and softer than natural. The calibre of the aorta was not increased, but the coats had a deeper tinge of yellow than natural, were rather thicker and had a few small points of ossification. The lungs were healthy, contained a preternatural quantity of mucus, and the lining membrane of the bronchi was more than usually vascular.

Fig. 68.



(a) the aorta slit open, in order to show the origin of the arteria innominate; (b) forming also the mouth of the aneurismal sac. The sac (c c) is laid open, in order to show the interior structure; (d d) a lamellated coagulum, which had consolidated the tumour; (e) the distal extremity of the subclavian, on which the

ligature had been applied; it is laid open to show the obliteration of that vessel; (f) the right carotid; (g) the left subclavian, and (h) the left carotid; (i) the trachea; (k) the right clavicle sawn through.

Such, indeed, were the results, and so satisfactorily did this interesting case prove the soundness of the principle on which this new mode of operating for aneurism was suggested, that the method was soon adopted both in this as well as in other countries, and has since been successfully resorted to in those cases for the cure of which neither the operation of Hunter nor that of Brasdor could be executed.

The next case in which an attempt was made to cure an aneurism by placing a ligature on only *one of the branches* of the diseased artery was under the care of Mr. Evans, an eminent surgeon, at Belper, in Derbyshire, and the result of the operation in this instance was still more satisfactory than in that of Mrs. Denmark, the aneurism being situated in the innominate as well as at the root of the carotid; and the ligature being applied on the carotid in place of the subclavian artery as in the former case¹.

An athletic young man, accustomed to laborious exercise, perceived, after a fit of coughing, a soft pulsating tumour about the size of a walnut, suddenly make its appearance behind, and extending a little above the right sterno-clavicular articulation, and covered, externally, by the sternal portion of the sternomastoid muscle. The tumour was greatly diminished by firm pressure, but could not be made to disappear entirely. Its pulsation was synchronous with that of the heart, was increased by pressure upon the right subclavian artery, and was *diminished* and sometimes completely arrested by pressure upon the right carotid. The pulsations of the right carotid and subclavian arteries were stronger than those of the left; but there was no apparent difference in the pulsations of the radial arteries.

Fig. 69.



Fig. 69 represents the form of this tumour.

¹ Lancet, 1828.

As soon as the tumour made its appearance, cough and dyspnœa, with which he had been some time affected, ceased to be troublesome, and his general health was soon re-established.

The situation of the tumour, its sudden appearance after a violent fit of coughing, and its soft pulsating character, led Mr. Evans to conclude that the root of the carotid artery was chiefly the seat of the disease. The patient was bled to the extent of eight ounces every third day, and he was enjoined to remain in bed and to live on small quantities of gruel, broth, and tea; small doses of digitalis were likewise administered. From this treatment there appeared some little improvement during the first month, but afterwards the symptoms increased, and finally the tumour reached as high as the cricoid cartilage, partially impeding both respiration and deglutition by its pressure on the trachea and œsophagus. His shirt collar, which, prior to his illness, could button comfortably, could not now be made to meet by upwards of three inches. His countenance became bleached, his pulse feeble, and it was considered that the depletive system of treatment had been carried as far as it could be with safety. Under these circumstances the operation of tying the carotid artery was performed. In consequence of the tumour extending so high up the neck, Mr. Evans found some difficulty in dissecting down to the sheath of the artery, which he laid open to the extent of half an inch; the vessel was easily secured by a single ligature of strong silk. Immediately after tightening the ligature the pulsations in the different branches of the external carotid ceased except a slight fluttering in the extreme branches of the temporal; but the pulsation of the tumour was not diminished. On the day following the operation the pulsation in the tumour was stronger than before the operation, and the pulsation of the radial artery of the right side was now more forcible than that of the left.

One of the most remarkable symptoms which afterwards occurred was the *obliteration of the arteries of the right-arm and fore-arm*, which change was first observed in the arteries of the fore-arm on the eighth day after the operation, for until that day the arteries of that arm pulsated with greater force than those of the left. This process of obliteration was attended with severe paroxysms of pain, chiefly felt in the course of the brachial and axillary arteries. The brachial artery, after its obliteration, was hard and painful to the touch; the arm wasted and became partially paralysed, and its bulk continued to diminish for three weeks, at the expiration of which period, several anastomosing branches were observed pulsating on the back part of the arm. As these vessels enlarged, the limb improved, though slowly, nor did it perfectly acquire its powers of motion and sensation until three months afterwards.

On the eleventh day after the operation the patient was attacked with paroxysms of

pain in the right side of the head and face, which continued about a fortnight, and the pain was of the same character, though not so violent as he had experienced in the right-arm. The right side of the head and face at the same time became emaciated, and any one could immediately discover that the right half of the face was much smaller than the left. The blood afterwards found its way into the temporal and facial arteries, and the right side of the face then became nearly as plump as the left.

Three weeks after the operation he got out of bed, and then perceived that the whole of the right side was numbed and weaker than the left. The pulsation in the tumour, which had hitherto been more powerful than before the artery was tied, now began to diminish rapidly; and on the thirty-third day after the operation, it had so much diminished, that it was doubtful whether the swelling arose from the passage of blood into the sac, or from an impulse given to the tumour from the subclavian artery. In five weeks after the operation, he was sufficiently recovered to take exercise daily on horseback, and from that time he continued to improve in health and resumed his usual avocations.

Nine years have now elapsed since the operation, and I have learnt from Mr. Evans that this patient "continues to enjoy most excellent health, but that his right-arm has not yet recovered its usual fulness and strength though nearly so."

The *third* case of aneurism of the innominate, in which this mode of operating was adopted, was under the care of Dr. Mott, Professor of Surgery at New York, an account of which case I received from him along with the subjoined letter; the testimony and approbation of so distinguished an individual was at that time the more gratifying to me, as some persons, not satisfied with disputing the opinions I had advanced, endeavoured, for unworthy purposes, to impugn the veracity of statements which so many members of the profession, had ample opportunities of ascertaining to be strictly correct.

SIR,—With much pleasure I send you the accompanying case of Aneurism of the Innominate, treated by tying the carotid artery. It is the first of the kind which has been performed in this country, and I am persuaded that its success will be interesting to you, as additionally confirmatory of the great principle so ably and so fully established by yourself, which improvement must be numbered with the greatest in modern surgery; conferring upon the talent, genius, and acquirements of its advocate the highest honour and the most lasting fame.

As applied to aneurismal tumours, hitherto deciding the fate of the patient, and pronouncing him the certain victim of incurable disease, it must receive the approbation of the profession and the gratitude of the phi-

lanthropist. For the particulars of the case I take the liberty of referring you to the accompanying paper, and I am happy to present this account of the first operation performed in America for the cure of aneurism of the innominata, to the discoverer and first successful performer of it in Europe.

With sentiments of respect,

I remain, Sir,

Your obedient servant,

VALENTINE MOTT.

New York, Feb. 15, 1830.

A farmer, sixty-one years of age, applied to Dr. Mott with a pulsating tumour about the size of a pigeon's egg, which extended some distance under the sternal and clavicular portions of the right sterno-mastoideus muscle, and as low down as the second rib. About three years before, whilst occupied in removing a building and compelled to lift heavy weights, he was attacked with pain in the upper and back part of the neck. The pain extended to the right shoulder and arm, and having continued during some weeks, then partially subsided, his voice at that time becoming hoarse. While shaving himself, about eighteen months afterwards, he discovered a small swelling at the upper part of the sternum, in which he felt a throbbing.

The tumour having now become very sensible to the touch, and respiration being impeded by the slightest pressure, its pulsations being synchronous with those of the heart, the tumour was considered as decidedly aneurismal. Dr. Mott advised him to avoid all exertion, to be occasionally bled, and to confine himself principally to vegetable diet. In four months the tumour above the sternum had much increased, the "bellows' sound" was distinctly heard, the thoracic viscera were healthy, and the respiratory murmur distinct throughout. By speaking, walking, or coughing, his respiration was very much impeded, and almost entirely suspended by the least pressure upon the tumour. The action of the right carotid was much more feeble than that of the left, and its branches did not pulsate. The right subclavian artery beat naturally, whilst the axillary and brachial vessels could scarcely be felt. No pulse could be felt at the wrist of the right arm.

Reflecting on this case, Dr. Mott was persuaded that the aneurism was situated in the *arteria innominata*, involving also the subclavian and root of the carotid arteries, and he considered it as a proper case for placing a ligature on one of the branches of the innominata. From the evident interruption of the circulation in the right arm, and the apparent efforts of Nature to effect a spontaneous cure, Dr. Mott determined first to tie the carotid, and afterwards to secure the subclavian artery, should it be required.

The carotid artery was secured in the usual manner, and on the following day the pulsation and size of the tumour were evidently diminished, and the breathing became more free.

His voice improved gradually, and his cough and expectoration diminished. The ligature came away on the twenty-sixth day after the operation, the tumour above the sternum and pulsation having entirely disappeared. The wound soon healed, but a very considerable weakness of the arm remained, with slight œdema, and there was no pulse in the right radial artery. His breathing had become easy, the cough and expectoration much diminished, and he could sleep in positions which he had been unable to take for many months.

After the return of Moses Gardner to the country, he stated in one of his letters, that "his breathing was much better, and his friends were much struck at his improvement, particularly the disappearance of the tumour." On the 22d of April, however, I received information of his death. It appeared that the difficulty of breathing had returned, and threatened at times immediate suffocation.

"*Dissection.*—No tumour appeared externally; the right clavicle was a little elevated, and, on removing the integuments, was found partially dislocated from its sternal articulation, and a considerable portion of its under surface was absorbed. Immediately beneath, and imbedded in the surrounding parts, was the tumour, which extended from the sternal extremity of the left, to about the middle of the right clavicle, along the upper and inner surface of the sternum, and reached as low down as the third rib. Laterally it was adherent to the right lung, and posteriorly rested upon the lower cervical and upper dorsal vertebrae.

"The trachea was greatly displaced, and very much flattened by pressure of the tumour, to which also it was closely attached.

"The tumour was about the size of two fists, and its parietes were firmly consolidated. It emanated from the *arteria innominata*, involving the subclavian and root of the carotid. Superiorly it was of a globular form, but terminated, inferiorly, in a point which passed down below the division of the trachea, and behind the aorta. The right carotid was obliterated; the right subclavian beyond the tumour was pervious and natural in its structure; the heart and lungs were sound.

"The attending symptoms, as well as the dissection, fully prove the cause of death to have been the displacement of the trachea, and the consequent pressure of the consolidating tumour upon it and the bronchial tubes. Had the operation been performed at an earlier stage of the disease, there is every reason to expect it would have terminated successfully. Should I have another opportunity, I will operate without any delay, and tie both vessels at the same time, and not leave one for a future performance, to be decided upon by the effect of the first."

The fourth case of aneurism of the innominata treated according to this new method of operating was under the care of Dr. Morrison, of Buenos Ayres, and an account of it was

first published in the *American Journal of the Medical Sciences* for 1837.

The patient, a man forty-two years of age, had a large pulsating tumour in the neck which extended upwards from within the thorax, and obliquely outwards behind the sternal extremity of the sterno-cleido-mastoid muscle. The tumour did not perceptibly diminish when pressure was made on the right carotid artery, but the pulse at the wrist of the right arm became fuller and stronger. When pressure was made on the right subclavian the impulse of the tumour was increased, as also the pulsation of the temporal and facial arteries of the right side. He had been chiefly confined to bed during the preceding nine months, labouring under pain in the cardiac region, difficulty of breathing, which was increased to a painful degree by walking, —rheumatism of the right shoulders and muscles of the neck, and hemicrania.

Concluding the tumour to be an aneurism of the innominate and right carotid, on the 8th of November, 1832, Dr. Morrison placed "a flat silk ligature on the *carotid artery*." In the afternoon, the patient complained of being much distressed "by hollow sounds in the right side of his head, and the pulsation in the tumour was so violent that they could be observed at some distance from the bed." The febrile symptoms were alleviated by repeated blood-lettings; and on the ninth day the tumour, which had become tender to the touch, began to pulsate more feebly, to become harder, and to diminish in size. The ligature came away on the thirty-first day, after which period he progressively recovered, and returned to his usual habits, which were those of very hard labour.

About nineteen months afterwards he complained of an oppression at the chest, with a slight cough, and in a month he died. On examination after death "the right subclavian artery was traced to its origin, at which place it was partially dilated. The *arteria innominate* was double its ordinary size, and studded with spiculæ of ossific matter. The right carotid artery, from its origin to the point where the ligature had been applied, was dilated into a sac, which was plugged up with a dense fibrinous deposit."

M. Laugier, an eminent French surgeon, operated upon the *fifth* case of aneurism of the innominate, in the year 1828¹. The neck presented a pulsating tumour the size of a large hen-egg. It extended about two inches above the right clavicle, whose sternal extremity it had dislocated and pressed against the trachea, which was pushed to the left side. Outwards, it reached to near the middle of the right clavicle, and downwards about two inches from the top of the sternum.

These symptoms might have led to a belief that the subclavian and right carotid arteries were alone affected; but there was great reason to suppose that the innominate, and perhaps even the arch of the aorta itself, par-

ticipated in the disease. The inclination of the trachea to the left side, the dull sound on the first and second ribs, where no tumour was perceptible; the difficulty of breathing; the peculiar resonance of the voice; the impossibility of feeling the termination of the tumour below the clavicle, joined to the consideration of the frequency of co-existent aneurisms of the innominate and aorta, were the principal sources from whence M. L. formed that diagnosis.

M. Laugier determined on taking up the *right subclavian artery* soon after it passes beneath the clavicle, and which he tied with a single silk ligature. No visible change occurred in the tumour immediately after the ligature was tightened, but on the following day it was evidently smaller, its pulsations were weaker, and the radial artery of the right side did not beat. The patient continued relieved, breathing better, and swallowing with less difficulty, until the seventh day after the operation, when a slight hæmorrhage took place of arterial blood from the wound. The bleeding returned several times, but ceased after the tenth day. On the fifteenth day, the patient perceived that the trachea was resuming its natural position, but he complained of pain in the shoulder and back, and was only able to sit with his body bent forwards, the pulse in the right wrist having then become sensible to the touch. Sometime afterwards, the tumour began to beat more strongly than before the operation, the cough and difficulty of breathing increased, and he died one month after the operation, the ligature still remaining in the wound.

On examination after death there was found a large aneurismal tumour of the *arteria innominate*, and the aorta was dilated. The sac was nearly filled with firm dense laminæ of fibrine; the lower part of the tumour containing more recently-formed coagula. The right carotid artery was completely obliterated from its origin to two-thirds of its extent, and presented several "singular valvular-like pseudo-membranes." The right subclavian artery was quite pervious to within an inch of where the ligature had been applied. The ligature had divided the artery, but was retained in the wound by a coagulum which had formed in its noose in consequence of the hæmorrhage. Besides, close to the capillary mouth of the artery there was a collateral branch of considerable size, which may have been the cause of the hæmorrhage, by preventing the formation of a sufficient internal coagulum. The third and fourth dorsal vertebræ were carious, and formed the parietes of the lower and back part of the aneurismal sac. Exactly in this situation the trachea was diseased, its inner membrane being thickened, discoloured, and its follicles very prominent. The œsophagus was here ulcerated, and communicated with the diseased vertebræ.

The next, and *sixth* case, was that treated by Mr. Fearn of Derby¹, and is one of much

¹ *Lancet*, 1828.

¹ *Lancet*, 1836.

interest and importance. A female, twenty-eight years of age, had a violent fit of coughing on going into bed, and soon afterwards she felt a throbbing swelling above the sternum, which, for a few weeks, gave her a good deal of pain, and which was relieved by repeated bleedings. Five months after the commencement of this illness there was a rounded pulsating tumour observed in the neck above the sternum, bounded laterally by the trachea and tracheal margin of the sternocleido-mastoideus muscle. The "bellowssound" was heard in the supra-clavicular space, and a less distinct sound along the course of the right carotid artery. The pulse in the right wrist was very distinct. She complained also of a frequent cough and difficulty in breathing; each time the carotid was compressed the breathing became more tranquil, and when the pressure was removed the dyspnœa instantly returned;—a similar experiment on the subclavian artery did not at all affect the state of her breathing.

The circumstance of the circulation in the subclavian artery being already considerably obstructed, and its entire obstruction adding to the distressing symptoms—and the further circumstance, that pressure on the carotid was followed by a relief of the dyspnœa, seemed to Mr. F. clearly to indicate, that for the cure of this aneurism a preference should be given to placing the ligature on the *carotid artery*. This he did accordingly by tying that vessel with a single ligature. A few hours after this operation the patient's breathing became a good deal oppressed, and she had many violent fits of coughing; but these symptoms were relieved by blood-letting and opiates: and they again several times recurred and were relieved by the same system of treatment. After the first eight days, a decided amendment took place in this patient's condition; the pulsation of the tumour diminished in force, its bulk was lessened, and the breathing was much more easy. At the expiration of a month the patient walked daily, her difficulty in breathing was entirely removed, and returned only when she walked fast. The tumour still continued to pulsate, but pressure upon it did not give rise to dyspnœa or any kind of inconvenience. In this state she returned home, no further treatment being deemed necessary.

Besides these six cases of aneurism of the innominata, which were treated by placing a ligature only on one of the branches of the diseased artery, two other cases are on record wherein a similar principle of operating was adopted. In one of these Mr. Scott placed a ligature on the right *carotid artery*, after which the aneurism somewhat diminished in bulk, but the tumour soon again increased, and ultimately proved fatal; however as there was no post-mortem examination, the real state of the vessels in this patient was not ascertained¹.

In the other case, a ligature was placed on

the *subclavian artery* by Mr. Key, and the patient expired a few hours after the operation.

On reviewing the eight cases in which this operation for aneurism of the innominata has been performed, it therefore appears that in five of them a ligature was placed on the carotid artery, and in the other three the subclavian was the vessel on which the ligature was applied.

In five of the cases the operation was followed by relief of all the symptoms, and by a diminution of the bulk and consolidation of the tumour. The three other cases were unsuccessful; but this militates not against the principle of the operation itself, but the injudicious selection of the patients on whom it had been employed. In M. Laugier's patient the consecutive hemorrhage was a proof of the diseased state of the artery at the place where the ligature was applied, and the appearances after death pointed out that the operation in this instance, where the aneurismal disease was so extensive, was by no means judicious. Neither can the unsuccessful result in the case operated upon by Mr. Key, where the patient died a few hours after the operation, be considered as any proof of the disadvantages of this mode of operating, but of its misapplication; and in the case which was operated upon by Mr. Scott, there is every reason to believe that the aneurism was too far advanced, and the vessels too extensively diseased, to admit of any benefit from the operation.

In operating for aneurisms within the chest, it is of importance to remark, that the success of the operation will not depend altogether on the satisfactory effect of the ligature, and the consolidation of the tumour. Patients with a large aneurism, or even with one of no very considerable bulk, are often destroyed from the mere pressure of the swelling on parts essential to life; so that although the tumour be consolidated, the mere bulk of an unyielding mass may cause a multitude of distressing symptoms, and even prove fatal. In operating therefore for aneurisms of the innominata particularly, it is essential for this as well as for other reasons, that the tumour should not have attained a very large size.

It is in cases of aneurism of the *arteria innominata* that I consider the operation of tying one, or perhaps both, of the branches of that vessel, in an especial manner applicable; and in the application of this principle the first important point of inquiry ought to be, whether blood continues to circulate through both the carotid and the subclavian arteries, or through only one of these divisions of the innominata. I have already stated that there were some examples of aneurism of the innominata wherein Nature had shut up the carotid, and others wherein the subclavian was obstructed, and thus had, in part, accomplished the consolidation of the tumour.

When the aneurism has not attained so great a bulk as either to produce serious affections of the head or chest, or to threaten

¹ Lancet, 1834.

rupture, and when under such circumstances both the divisions of the innominata remain open, I would then be satisfied with first making a trial of Valsalva's system of treatment, in the hope that, ultimately, at least one of the vessels might be obliterated and the sac filled with concreted fibrine. Should however, so favourable a change not ensue, the propriety of tying one of the branches of the innominata is then to be considered; and it appears to me that such an operation ought to be unhesitatingly adopted in cases which would otherwise be hopeless. I may here observe, that it will perhaps be a matter of no small difficulty to ascertain when one of these arterial trunks is obliterated, and I as well as others have been more than once deceived on this point. Conceiving that a want of pulsation was a sufficient indication of the closure of an artery, I formed an erroneous opinion in the case of Mrs. Denmark; from the pulsation in the carotid and its branches not being perceptible, I supposed that the canal was plugged up; but in a short time after the ligature was placed on the subclavian, I was surprised to find the pulsations of the carotid return, and ultimately resume their wonted vigour.

It is a fact demonstrated by dissection, and worthy of remark in contemplating this mode of operating, that when a spontaneous cure of aneurism of the innominata has been going on, Nature has usually plugged up the carotid, so that in performing an operation for the cure of such an aneurism it would be advisable to imitate her in this respect, and to place the ligature on the carotid, in preference to the subclavian. The advantage of this practice is obvious, for as no vessels pass from the carotid between the ligature and the sac, a greater diminution in the force of the circulation in the tumour will follow than if the subclavian were tied, it not being practicable to apply a ligature on that vessel without leaving four large branches between the ligature and the sac. I have been taking for granted that the calibre of the carotid and subclavian was about equal.

The innominata (d), divides into two great branches; the right carotid (e), and the subclavian. The subclavian gives off five large branches before it emerges from beneath the scaleni muscles; (f) the vertebral artery; (g) the internal mammary; (h) the superior intercostal; (i) the thyroid axis; (k) the deep cervical; and (l) is the trunk of the subclavian, after it has passed beyond the scaleni muscles, and the point where the ligature is to be applied.

In the practical application of this mode of operating for aneurism, it will be of great importance to be able to form an accurate diagnosis in aneurismal swellings of the neck, those particularly of the arteria innominata, and those at the roots of the carotid and subclavian arteries. Such diagnosis is generally considered extremely difficult; and erroneous opinions have in several instances been formed as to the site of such tumours by experienced surgeons. I apprehend, however, that the difficulty of distinguishing aneurisms of these different arteries from one another has chiefly arisen from the circumstance of their having been all considered incurable, at least by operation; and as far as the treatment is concerned, the same system being applicable to all of them, no one has endeavoured to point out their diagnosis.

Having had frequent opportunities of examining aneurisms at the root of the carotid and of the innominata, I think that tumours of these different vessels may be generally distinguished from one another; and the diagnostic characters I have chiefly derived from a consideration of the natural position of the vessels and their relative situation to the surrounding parts.

When an aneurismal swelling is formed at the root of the carotid, the tumefaction will first be perceived in the small triangular space formed between the heads of the sternal and clavicular portions of the mastoid muscle; and as the tumour increases in bulk, it displaces more or less, or sometimes produces the absorption of a portion of either the one or the other of the heads of that muscle.

If the aneurismal swelling be formed in the arteria innominata, then, in place of first making its appearance between the two heads of the mastoid muscle, at the bottom of which space lies the carotid artery, covered merely by a loose cellular membrane and some fat, the tumour rises up from below the sternum, and on the tracheal edge of the sternal portion of the mastoid, where the innominata is most uncovered. The situation of the tumour, however, varies according to the part of the artery that is affected; in one case, where the rupture of the internal coats of the innominata took place at the distal extremity of that vessel, the other coats yielding in the direction of the impetus of the blood, the tumour took a diagonal direction between the lines of the carotid and subclavian, and thus first appeared in the triangular space on the acromial edge of the mastoid muscle.

When the aneurism is formed in the subclavian artery, the tumour will rise on the cervical side of the clavicular portion of the mastoid,

Fig. 70.

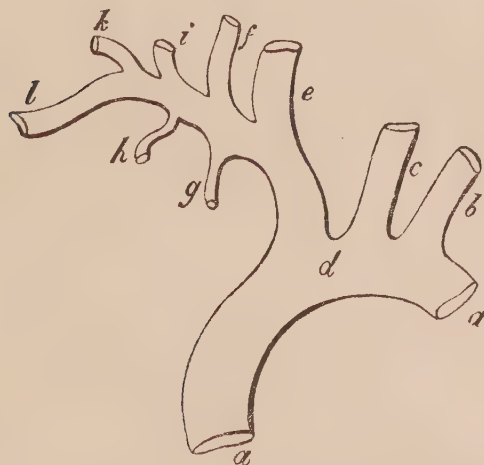


Fig. 70. This diagram shows the subdivisions of the arteria innominata; (a a) the aorta from whose arch the three great trunks, (b) the left subclavian, (c) the left carotid, and (d) the arteria innominata emerge.

in the triangular space between that muscle and the trapezius, where, like the former vessels, the artery is covered only by some fat and condensed cellular membrane. It is, indeed, in these several spaces where the three different arterial trunks are most exposed, and where the superincumbent parts are of that nature which most readily yields to the growth of the aneurismal swelling.

Another diagnostic mark in aneurismal disease of these vessels is the state of the pulsation in the branches of the subclavian and carotid arteries; the force of the pulse being usually diminished in the branches of a trunk affected with aneurism. Thus, when the carotid is the seat of the disease, its branches only will have their pulsation affected; when the subclavian suffers, the radial artery will pulsate with less force; and when the innominate has become aneurismal, the circulation in the branches both of the subclavian and carotid will be more or less influenced.

I may also observe that in proportion as the aneurismal tumour acquires considerable bulk, the diagnosis will become more and more difficult, and the difficulty will, in many cases, arise from the circumstance, that two or more of these vessels, and in many instances the arch of the aorta itself, are involved in the disease.

In addition to these cases of aneurism of the innominate, aneurisms of other arteries have likewise been treated by placing the ligature on *one branch* of the diseased trunk. Sir Everard Home adopted this practice, and placed a ligature on the trunk of the common *femoral artery* in a case of aneurism of the external iliac¹. But the operation failed, and he afterwards endeavoured to cure the aneurism by coagulating the blood within the sac by the application of heat. Dupuytren tested this mode of operating in a patient who had an aneurism of the subclavian, by placing a ligature on the *axillary artery*; but the case was not a favourable one for any operation, neither was the after-treatment likely to ensure a successful result.

"A husbandman, forty-five years of age, who had always enjoyed good health, experienced, without any assignable cause, a feeling of numbness and weakness in the whole extent of the right arm, and this was quickly followed by a painful sensation at the lower part of the neck, in the clavicular region. The tumour was constantly increasing in size, the arm became more numbed, and finally the numbness increased so much as to render his arm almost immoveable. Dupuytren at first tried Valsalva's method of treatment, combined with cold and discutient applications to the tumour, and though the patient had been bled seven times, and kept on a very low diet, still the tumour, instead of diminishing, continued to augment. The subclavian artery in the space between the scaleni muscles and the clavicle had acquired the size of an egg, and formed

a tumour of considerable size outwards and upwards towards the trapezius. Below the clavicle the artery appeared healthy, but M. Sanson believed that the disease extended beyond that bone; the trunk of the common carotid appeared sound, but the strong and full pulsations of the commencement of the subclavian and of the innominate showed that both those vessels were likewise affected, although certainly to a less degree than the subclavian itself. The integument covering the tumour had not altered; the arm and hand of the right side were slightly œdematous; the hand was partly closed, and the patient could neither open it nor close it more. The whole of the limb was affected with great numbness and painful twitchings. The right arm was of the natural colour and temperature, and the general health good; the pulsations of the heart were strong and sonorous; the respiration easy; cough slight, but not frequent."

"Dupuytren conceived, that if the method of Hunter or Anel were admissible, it would be necessary in this case to apply the ligature on the origin of the subclavian, which itself was much affected, or on the trunk of the *arteria innominate*, which for the same reason could not be tied; besides the trials already made by MM. Mott, Græfe, and Lisfranc had not been sufficiently encouraging to lead one to perform the latter operation. There remained then but one alternative, either to abandon the patient to a certain death, or to treat him according to the method of Mr. Wardrop, and tie the *axillary artery*.

"M. Dupuytren performed this operation, and at the moment when the circulation was arrested by the ligature there occurred about twenty very strong pulsations of the tumour, which appeared for the time to augment in size, but very soon resumed their ordinary rhythm, and the patient felt very comfortable."

"On the following day the tumour was slightly diminished in size, and its pulsations less strong. On the fifth day there was some uneasiness, the pulse was stronger, and some paroxysms of cough having caused the tumour to swell, he was bled at the arm. On this day about noon, the compresses covering the wound were stained with arterial blood; he was again bled, and in the evening a third time, the discharge of blood continuing. On the next day the flow of blood was nearly stopped; bled in the evening to one 'palette.' The seventh day from the operation the patient appeared to be going on well, complaining only of debility and slight dyspnœa; bowels not opened since the operation; he takes every hour a small quantity of nourishment. On the eighth day the discharge of arterial blood again made its appearance, but in very small quantity: the tumour had much diminished in size; the limb was slightly tumefied, but preserved its sensibility, the dyspnœa, however, was slightly increased; the patient continued to get weaker, and died on the ninth day at four o'clock in the morning."

"On examination there were but few traces

¹ Philosophical Transactions, 1826.

of the tumour; the pleura contained about a glassful of sanguineous serosity, but the left side contained more than the right; the left lung was healthy, the right covered with recent false membranes; it was slightly infiltrated, and the posterior portion of its middle and inferior lobes engorged, approaching to hepatization; the heart greatly dilated, its parietes appeared rather thinner, and almost resembling two leaves of parchment; and its substance pale. The aorta was much dilated and thickened, presenting on its internal surface large red patches; in other parts the internal membrane presented true ulcerations, of which some corresponded to osseous patches, others to a white and firm substance. This alteration terminated at the diaphragm. Traces of it were found in the arteria innominata, which was much dilated; also to a small distance in the common carotid and in the right subclavian in a more advanced state, the calibre of which vessel was equal to that of the innominata. The tumour rested on the first rib, the middle portion of which it had completely destroyed, the extremities of the bone projecting into the interior of the sac and covered by a fibrinous coagulum."

"With respect to the operation, it had been as successful as possible, and had surpassed every thing which could have been expected: every thing went on well for the first days, and it is probable that if this slight hæmorrhage had not inspired alarm, and rendered the venæsections necessary in a patient who had already been bled seven times previous to the operation, he would have been able to have borne up against the slight affection of the left lung and that of the pleuræ; further, it is even probable, that these lesions only supervened during the latter period of the patient's life, when the organization, deprived of all its powers, no longer possessed means of resistance."

"This case is not then a failure (revers) for surgery; nor can it be cited as unfavourable to the method of Mr. Wardrop. M. Dupuytren stated, and with reason, that considering the death as the effect of the lesions of the thoracic viscera, and not as the result of the operation, he should not abandon, on this account, the method which he had employed, and which was the only one that could have been put in practice in such a case. He reminded persons that Sir A. Cooper had experienced the same failure the first and second time he placed a ligature on the carotid; that he himself lost the first patient in whom he employed the method of treatment for artificial anus; and he concluded by assuring those present that, in a similar case, he should act in the same way as he had done in this¹."

Ligature.—Having considered the effects of artificially obstructing the passage of the blood through an aneurismal artery from placing a ligature on the vessel, on the cardiac or on the capillary side of the tumour, or on one

branch only of the diseased artery, a most important inquiry, viz. the best mode of applying the ligature under any of these circumstances, still remains to be determined. Were it, indeed, practicable to apply a ligature on an aneurismal artery, so as to avoid all risk of consecutive hæmorrhage, the operations employed for the cure of external aneurism might be said to be perfect in all cases in which an operation would in other respects be advisable.

Various methods have been employed for applying ligatures on aneurismal arteries. In the old operation, in which an incision was made into the sac, the cardiac, and distal orifices of the diseased vessel were secured in separate ligatures. But since other modes of operating have been adopted, and it has been found requisite to cut down upon an arterial trunk, at a distance from the aneurism, with a view to obstruct the flow of blood through the vessel at that point, different means have been employed for placing the ligature on the vessel, the chief object being to lessen the risk of consecutive or secondary hæmorrhage.

The most simple method of employing the ligature consists in tying a single thread round the artery with sufficient tightness not only to interrupt the flow of blood through it, but also to cut its internal coats, and compress its sides, at the point of ligation.

Effects of its application.—When a ligature is thus applied on the trunk of an artery, a series of changes takes place, all which become necessary to secure the vessel from future hæmorrhage; and any of these changes, if not duly effected by the ligature, render the operation extremely hazardous and often fatal. The first effect produced by tying a thread tightly round an artery is to obstruct the transit of the blood through it. The circulation being thus arrested, that portion of blood, which is contained between the ligature and the first collateral branch on the cardiac side of the ligature, stagnates and forms a coagulum. This clot serves the purpose of a temporary barrier, and the inflammation, arising at the lacerated ends of the internal tunics of the artery, is followed by the effusion of coagulating lymph or fibrine. An adhesion is thus produced between the opposite sides of the vessel at the point of ligation. The coagulum of red blood is gradually absorbed, and replaced by a plug of concreted fibrine. Whilst this process is going on within the vessel, the ligature acting as an extraneous substance, and the noose having been drawn so tightly, as to destroy the vitality of the coats of the artery at the point of ligation, causes that part of the vessel to ulcerate, and thus allows the ligature to be separated. As soon as the ligature has come away, the wound of the parts, as well as the extremity of the artery, becomes covered with granulations, and ultimately the vessel is imbedded in a firm and condensed mass of cellular tissue.

The noose of the ligature may be either drawn so tight as only to bring the opposite

¹ Archives Générales de Médecine.

sides of the vessel into close contact, or the inner and middle coats may be divided or lacerated by its pressure; and such division of the inner coats has usually been considered requisite to produce the necessary degree of inflammation of the tunics of the artery, as well as a sufficient exudation of fibrine to secure its closure, and the separation of the ligature. The moderate degree of force which is found sufficient to cut the internal coats of an artery in the dead body, and also in living animals, renders it probable that in the usual mode of applying the ligature, the division of the internal coats of the vessel almost always takes place; the degree of inflammation necessary for the closure of the vessel may, it is true, be produced without this division, but when the noose is tightly drawn, though it may create an additional risk of hæmorrhage, if the coats of the vessel happen to be diseased, it will secure an early separation of the ligature itself.

A *temporary ligature* has also been employed for the cure of aneurism. It had been ascertained, by experiments on animals, that when a thread is tied with sufficient tightness to lacerate the internal coats of an artery, and is allowed to remain on the vessel but a very few hours, an internal clot of blood is formed sufficient to oppose an obstacle to the circulation in the vessel, whilst a sufficient degree of inflammation subsequently ensues to produce adhesion of the coats of the vessel, and a permanent obliteration of its canal. In the few cases in which the temporary ligature has been applied on an aneurismal artery, the results have been such that the practice has not been generally followed; and even had the precise period necessary for the application of the temporary ligature been accurately ascertained, it would be still a matter of doubt whether or not there would in that case be less risk of secondary hæmorrhage, than when a permanent ligature had been employed; for as the force used in tying the ligature would in either case be the same, any risk of hæmorrhage from the artery being diseased at the point where it was tied, would be precisely the same in both cases. Moreover, the danger of hæmorrhage for want of sufficient space between the ligature and the nearest collateral branch to procure the stagnation and coagulation of a sufficient quantity of blood to form the temporary barrier, would be equal whichever of these modes had been employed.

The want of success which has hitherto attended the use of the temporary ligature, must not, however, be considered a conclusive proof of its principle being incorrect, but rather of the difficulty of attaining the object for which the temporary ligature is intended. It is evident that there must be a specific period, when a ligature applied in the ordinary manner must have effected all the good purposes that are required of it. Beyond that period, its longer detention in the wound cannot be of any use, and may be productive of much mischief. If, therefore, the ligature

could be removed from the vessel immediately after the adhesion of its coats had taken place, and a coagulum been formed, without in any way disturbing the vessel, or interrupting the adhesive process that is going on in the wound, there would still be good grounds for employing a temporary ligature on an aneurismal artery. It appears to me that a plan suggested by Mr. Barker of Ipswich, for removing a ligature at any period that may be required after its application, is admirably calculated to accomplish this important purpose. By this plan, the surgeon has the power of loosening the knot of the ligature, by withdrawing a thread, without causing the slightest disturbance of the vessel. This is accomplished with a remarkable degree of facility, in the following ingenious manner:

The substance best suited for the ligature, is the common, small-sized cat-gut; two small loops of different coloured silk are also required. After the ligature has been conducted by the needle under the artery, one end of the ligature is passed through the first loop, *a*, and then the first noose of the knot is completed, and drawn with the usual tightness. The same end of the ligature is passed through

the second loop, *b*, (fig. 71), and then the second knot is completed; that end of the ligature which is close to it, *c*, is then cut off. The edges of the wound

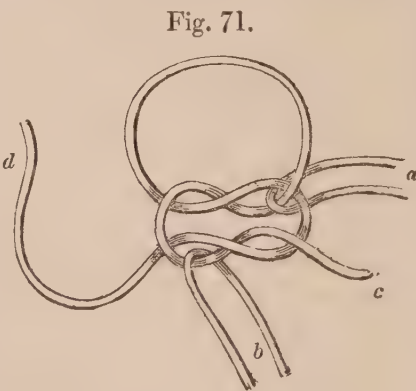


Fig. 71.

being brought together, the two small loops and the long remaining end of the ligature, *d*, are to be brought out of the wound. Whenever it is desirable to remove the ligature, the surgeon commences by drawing one side after another of the second loop, *b*, in a see-saw manner. The noose of the knot will be thus speedily loosened, and the loop escapes out of the wound. The remaining loop is to be manipulated in the same manner, and the knot will be thus completely undone, and the ligature now lying loose in the wound, may be withdrawn with the greatest facility.

Another mode of employing the ligature has been to apply several threads at a moderate distance from each other along the course of the vessel. This expedient was had recourse to for the purpose of having at hand the means of controlling the flow of blood in the vessel, if the lowest ligature, which alone had been tightened, proved insufficient; but the practice has very properly been long since abandoned. Its impropriety will be at once felt, when we reflect, that the effect of a ligature is to excite a degree of inflammation in the vessel, which extends for some way, both above and below the point tied; while this process is going on, the coats of the vessel are

more friable and unresisting than in the state of health, and if one or more ligatures are placed successively, one above another, while the artery is thus inflamed, the vessel is more easily cut through, and the consequences may be easily foreseen.

Another and indeed an ancient mode, which was advocated by Mr. Abernethy, consisted in the application of two ligatures, the artery being divided between them. To this mode of applying the ligatures, he was led by observing that secondary hæmorrhage was much more frequent after the operation for aneurism than after amputations; and he therefore anticipated that by placing two ligatures on an artery and dividing it between them, the upper extremity of the vessel, and which he erroneously supposed was the only one from which a secondary hæmorrhage could arise, would be, in this respect, precisely in the same circumstances as an artery tied after an amputation.

Of all these different methods which have been resorted to for placing the ligature on an aneurismal artery, that which is now almost universally employed in this country is the application of a single thread round the vessel in such a manner as to cause as little injury as possible to the adjacent soft parts, the noose being tied sufficiently tight to divide the inner coats of the vessel. There is, indeed, no operation which, if properly executed, is followed with more certain success than that of obliterating an arterial trunk by the application of the single ligature; how far such a procedure may be advisable for the treatment of particular cases of aneurism, is another point to determine: for in this, as in all other surgical operations, the ultimate success depends on the proper selection of the case, its previous treatment, and likewise on its after management. What I now contend for is, that if a single ligature be placed on an arterial trunk, the coats of which are healthy at the point of ligation,—if a sufficient space be left between the ligature and the first collateral branch for the formation of an internal clot; if the noose be made sufficiently tight not only to insure the adhesion of the sides of the artery, but also to cause a speedy ulceration of the coats to permit the escape of the knot; and above all, if this operation has been accomplished with facility and without detaching the vessel from its sheath and the soft parts contiguous to the sheath of the vessel to any unnecessary extent; and, finally, if the wound is not irritated after the operation by extraneous substances, this operation is almost invariably attended with success.

On reviewing the numerous cases of aneurism which have been operated upon since the Hunterian method was introduced, the cases in which it has been unsuccessful, have, in almost every instance, excepting those which were injudiciously selected for a surgical operation, failed from secondary hæmorrhage; whilst of late years, since important improvements have been made in the application of the ligature, and in simplifying the operation,

the surgical treatment of aneurism can now be resorted to with great certainty, as far at least as regards the obliteration of the artery, whatever may be the changes effected in the aneurismal tumour.

To secure the success of the ligature, several circumstances are indispensable, besides those which relate to the mere application of the thread.

1st. No branch should come off from the trunk of the artery within a certain distance of the point of ligation, a space being necessary for the blood to stagnate and coagulate, and in which a fibrinous concretion may be ultimately formed, in order to produce a permanent barrier to the circulation. Whatever precautions may be taken, or however intelligent the operator may be, there is always a risk, either of some anomalous branch coming off close to the place where the ligature is applied, or the relative position of the parts may be so altered from the bulk of the aneurismal tumour, that the ligature is placed close to some collateral branch; and hence in either case, there not being sufficient room for the formation of an internal coagulum between such collateral branch, and the point of ligation, secondary hæmorrhage must follow whenever the coats of the vessel are ulcerated by the ligature. This accident has frequently happened when the operation has been performed on the trunk of the common femoral artery, in cases where the aneurismal tumour was so situated that there was not a sufficient space between the sac and the epigastric, or circumflex artery to permit the ligature to be placed, so as to leave a sufficient portion of the trunk of the vessel between the ligature and the origin of the branch for the formation of a coagulum.

2d. There should be no important deviation from the usual distribution of the vessel. When an anomaly occurs, we have to fear not only the danger arising from the ligature being applied too close to such a division of the artery, and preventing the formation of the necessary coagulum for its obliteration, but we have also to fear the continuance of the circulation on the capillary or distal side of the ligature. The more remarkable instances of these irregularities in the distribution of the arteries have been described by different authors, more particularly by Haller, Murray, Burns, Barclay, Tiedemann, Harrison, and Dr. Hennis Green, and will be referred to in describing the operations on particular vessels.

Mode of applying the Ligature.—There are certain points demanding particular attention when a ligature is to be applied on an arterial trunk, and which should be borne in mind, on whatever vessel the ligature is to be placed. The precise length of the incision in the integuments, after mature consideration, ought to be marked with ink. The length of the incision ought to be regulated according as the vessel may be more or less deeply situated, recollecting that the facility of the future dissection depends very much on a free inci-

sion having been made through the skin. The direction of the incision should not be exactly parallel with the line of the artery, but should cross it at an acute angle (fig. 72). This direction of the incision gives the operator the certainty of exposing the artery at one point of his incision; for if it be made parallel to the vessel, a difficulty may arise when the incision does not exactly fall upon the trajet of the vessel. The artery ought to be denuded as little as possible, and only at that point where the ligature is to be applied.

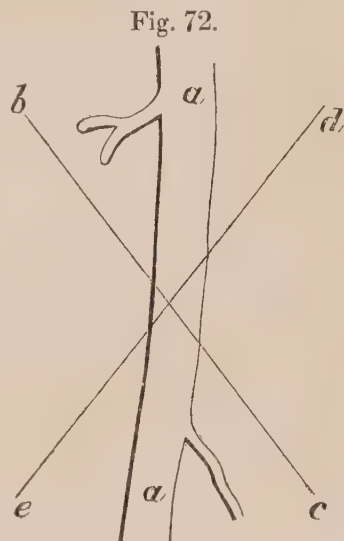


Fig. 72, *a a*, an artery crossed obliquely by the lines of incision, *b c*, and *d e*.

This mode of dividing the integuments offers essential advantages, not only in facilitating the future steps of the operation, but in affording the certainty of denuding the artery at one point, and only at that point where it is desirable the ligature should be applied. For if the operation be executed strictly according to this principle, the cellular sheath of the vessel will be exposed only to such an extent as to facilitate making an opening into it merely sufficient to admit the transit of a small needle for conducting the ligature round the vessel. The safety and success of the operation may indeed be justly said to depend on the ligature being applied without much disturbance to the soft parts contiguous to the artery, and likewise in the facility by which the needle is passed around it; and I am convinced that even the most experienced operators will find decided advantage in performing this operation, by adopting the oblique incision of the integuments which I have now recommended, instead of following the ordinary method of dividing the skin immediately above, and in a line parallel to the trajet of the artery; a practice which I am of opinion it will be better to avoid, even when operating on superficial arteries.

The advantages of marking the line of the incision with ink, before commencing an operation, should not be lost sight of, particularly in that of placing a ligature upon an artery. It frequently happens, that from the external incision not being of sufficient extent, the subsequent dissection is retarded, and it becomes necessary to extend the division of the skin, an inconvenience which can always be avoided by duly considering and marking the length of the incision beforehand.

The instruments necessary for dividing the integuments and performing the subsequent dissection, are, a scalpel, a directory, and a blunt-pointed knife.

The scalpel best adapted for this, as well as for most other operations, ought to have the back and handle made in one continued straight line, as represented in (fig. 73), *a b*.

Fig. 73.



By grinding a small portion from the back of the blade, at an oblique angle, a knuckle or projection *c*, is formed, which serves the purpose of guiding the sharp point of the instrument, the end of the operator's fore finger being applied upon it. With this instrument the incision is to be made down to the cellular envelope or proper sheath of the artery, and before attempting to open the sheath and expose the vessel, it greatly facilitates the operation to wait until the wound is cleansed from blood, when that is practicable; an assistant taking care to apply pressure on any bleeding vessel. The sheath of the artery being now distinctly seen, it is to be cautiously opened, conducting the scalpel by the director, and if this step of the operation be effectually accomplished, the aneurismal needle will pass with the greatest facility round the vessel; the cellular membrane, which lies between the artery and its sheath, being remarkably loose, yields readily even to a blunt-pointed instrument. If the artery be so deeply situated that it cannot be distinguished by the eye, the opening of the sheath is a step of considerable difficulty and great nicety; the difficulty consisting in ascertaining with certainty, that the sheath is opened. It is here that the form of scalpel which has been recommended would be found particularly useful, and the sharp point safely guided by the finger of the operator. In order to be assured that the sheath of the vessel was opened, when I had no means to ascertain it but by the sense of touch, before venturing to introduce the needle, I have always passed within the sheath a blunt-edged silver knife, with its point slightly curved, after which the aneurismal needle may with confidence be introduced. This step of the operation will be more safely and speedily accomplished by passing the needle between the artery and its accompanying vein or from within outwards, than from without inwards. By this mode of proceeding, there is much less chance of including the vein along with the artery within the ligature, an occurrence which I have known happen to experienced surgeons. The needle for conducting the ligature has been made of a variety of forms, and several different contrivances have been resorted to, to convey the ligature round deep-seated arteries. The most simple, and by far the most preferable aneurismal needle for general use, is of a curved form, somewhat like the letter S. (See LIGATURE.) When of this shape the point can be passed in various directions, and carried round a vessel of considerable depth.

The needle ought not to be so thick as those usually employed ; and whilst its point should not be so sharp as to endanger a wound of the artery, it ought not to be so large or so blunt as to prevent it being easily slipped round the vessel. Neither should the eye of the needle be too near the point, so that when the ligature is in it, the needle may not be interrupted in passing through the loose cellular membrane between the artery and its sheath.

The best ligature which can be employed is the common silk thread used by dentists, and a noose formed by a single knot is to be firmly drawn, guarding against pulling it so tightly as to lacerate the cellular coat of the artery. Due care should be taken before tying the ligature, that nothing be included in the noose but the denuded artery, and that the coats of the vessel are in a healthy condition ; and as it is of great importance, to diminish the risk of consecutive hæmorrhage, that a sufficient portion of the vessel be left between the ligature and the first inosculating branch, it is safer to tie the vessel at the farthest point which is denuded, than at that nearest the heart, by which means a larger space will be left in the vessel for the formation of an internal coagulum. The ligature having been tied, the ends of the thread may be either left in the wound, or one of them may be cut off, or both may be removed close to the knot. As it is essential for the success of this operation, that the wound be speedily healed, in order that the soft parts contiguous to the vessel may be consolidated, the small ligature is decidedly preferable, its presence causing less irritation, and, for this same reason, cutting off one of the threads will still further diminish the irritation arising from the presence of an extraneous body within the wound. (*Veitch.*)

In order still further to remove all causes of irritation in the wound, both ends of the ligature have been cut off, and this is, perhaps, all things being considered, the most preferable mode. When nothing remains in the wound but the noose on the artery, all the soft parts which had been necessarily divided in order to reach the vessel and pass the ligature round it, may be brought into close contact and retained in their natural position ; so that, except the very limited spot where the noose of the ligature remains, the whole of the wound will be readily united by adhesion ; and it is found from experience that the noose of the thread is ultimately discharged by an orifice formed in the cicatrix. (See LIGATURE.) The separation of the noose takes place at very different periods after the operation, according to the kind of ligature employed, the force with which it has been tightened, and the degree of local excitement that follows its application ; but no further degree of inflammation and supuration supervenes than what is necessary for the displacement and discharge of the ligature, and it is of advantage that the liga-

ture should not be separated until the canal of the artery be permanently obliterated.

The consecutive treatment. — The wound should be dressed in the most simple manner ; all the blood on its surface ought to be carefully removed, and the divided parts ought not to be brought together until the bleeding has completely ceased. The edges of the wound are then to be kept in contact by short strips of adhesive plaster, either with or without a few stitches ; and a bandage, when the operation has been performed on one of the limbs, may be applied, but only with a very moderate degree of firmness,—or bandages may be dispensed with altogether. All circumstances being favourable, the whole of the wound will heal by adhesion, scarcely any after-dressing being necessary ; and the noose of the ligature will be discharged in fifteen, twenty, or sometimes a greater number of days, unattended with any pain or inconvenience.

A series of changes take place in the vascular system, immediately on the application of the ligature, whether placed on the cardiac or on the capillary side of the aneurism, or on one of the branches of the diseased artery. The pulsations in the tumour either cease altogether, or a thrill more or less distinct may be perceived, and its bulk diminishes in proportion to the thinness of the walls of the sac. But as I have already explained (see ANASTOMOSIS), the circulation in the trunk of an artery is no sooner interrupted, than the anastomosing branches increase in size, to supply those parts with blood which had been nourished by the obstructed vessel. Hence, immediately after the application of the ligature, the inosculating vessels beat with an increased impulse, and, if situated near the surface, they may be seen to enlarge, as is well illustrated in the branches of the temporal and occipital arteries, when the trunk of the carotid is obstructed by a ligature.

A like diminution in the bulk of an aneurismal tumour is produced when the ligature is placed on its capillary side, or when only one of the branches of the aneurismal artery has been secured. In all cases where either of these modes of operating have been employed, it has been distinctly noticed, that a very considerable diminution in the bulk of the tumour took place immediately after the ligature had been applied on the diseased vessel.

When the patient has been subjected to a rigid system of preparation before the operation, it may be anticipated that no circumstance will ensue to interrupt the progress of the cure, the operation causing little or no disturbance of the general system, the tumour gradually becoming consolidated, and the limb being properly nourished by the enlargement of the collateral vessels. Until such a favourable result of the operation is produced, it is of primary importance, not only that the limb but that the whole frame should be kept in a state of perfect repose ; the strictest attention should likewise be paid to regulate the

patient's diet and keep his mind tranquil. The limb should be kept moderately warm, and whilst all cold applications ought to be avoided, it is equally proper to guard against too much heat and the application of stimulants to the limb. Unless interrupted in its efforts, the economy is active in restoring the collateral circulation; so that if from the application of heat or stimulants the vascular system be too much excited, inflammation of the wound or congestion of the limb may take place. The diet should be mild, and merely sufficient to allay the sensation of hunger, and the bowels ought to be regulated by mild laxatives or enemata.

With whatever facility the operation may have been performed, and, however favourable the circumstances may have appeared to be when it was undertaken, yet it is sometimes followed by a train of severe symptoms, either in the parts on which the operation has been performed, on the aneurismal tumour itself, or on the system generally. In some individuals the ligature of a large artery is succeeded by a greater or less degree of excitement of the whole system,—the pulse becomes full and hard, there is an increased heat of the skin, and perhaps, too, uneasy sensations are excited in the wound, in the tumour, or in some internal organ. In this state, the chief means to be relied on, are the abstraction of blood, sudorifics, laxatives, and such medicines as tranquillize the action of the heart. The quantity of blood to be taken can only be determined by the changes in the pulse which take place during the flow of the blood from a vein, and the blood should be allowed to flow until the pulse be subdued, the impulse of the heart diminished, or until a state of approaching syncope is produced. Should the large intestines not have been duly evacuated, an enema should be exhibited. One grain of calomel, taken singly or combined with three grains of James's powder, may be given every four, six, or eight hours alternately with a small dose of saline medicine, or the common saline draught, according to the violence and duration of the febrile symptoms. As in cases where any considerable degree of excitement has supervened after the operation, one bleeding is seldom sufficient to subdue permanently the febrile symptoms, the impulse of the heart and the pulse ought to be carefully watched, and when they rise again above their natural standard, or should there be any degree of local pain, whether in the tumour, or in the wound itself, under any of these circumstances the bandage ought to be replaced on the arm, and the blood allowed to flow until the increased action of the heart be again subdued. After the febrile state of the system has been combated, as far as can be effected by depletion, any immoderate action of the vascular system which remains may be allayed by the exhibition of the tartrate of antimony, opium, or colchicum. This depletive system may indeed be pursued with the greatest confidence,

recollecting the important fact I have formerly mentioned, that a languid state of the circulation, caused by the abstraction of blood, instead of preventing, essentially contributes to the rapid deposition of fibrine within the canal of a divided artery, or within an aneurismal sac. Hence a patient, on whom an operation for the cure of aneurism has been performed, cannot, to ensure its success, be too much depleted, as far at least as regards the obliteration of the artery at the point of ligation, and strengthening the walls of the sac by the formation of concremented fibrine.

Sometimes a limb becomes cold after a ligature has been placed on its main trunk. This seldom continues more than a few hours, and nothing is requisite but to keep it covered with some cotton or silk, taking care that it is so supported and covered, that no considerable degree of pressure be allowed to bear on any particular part. But if the coldness of the limb continues for a lengthened period, further means must be employed to restore its natural temperature, such as placing bottles of hot water, or flannel bags filled with heated salt, in the vicinity, but not too near the limb. Sometimes a cold state of the limb is succeeded by an increase of temperature above the natural standard; and even with such a degree of congestion as to render it necessary to apply leeches, or even to take some blood from the arm.

It sometimes happens, after either of the different methods of operating for aneurism has been employed, that sooner or later, even in a very few days, the aneurism regains its former size and again pulsates; a circumstance which may occur from a collateral branch arising from the artery between the point of ligation and the sac, carrying on the circulation through the tumour; or some branch communicating with the aneurismal artery on the capillary side of the sac, may, in like manner, cause a stream of blood to flow through the tumour. But whatever be the cause of the circulation being maintained in an aneurismal sac, it has been already pointed out, that a complete stoppage of the blood's current is not necessary to secure the success of the operation. It is only requisite to procure the formation of fibrinous laminæ within the sac sufficient in thickness to secure its walls against the impetus of the blood—an effect, which, in the cases alluded to, is produced by the very languid state of the circulation, which continues in an aneurism after a ligature has been placed on the trunk of the diseased vessel, rendering much resistance of the parietes of the sac unnecessary, and by the same languor of the circulation likewise promoting the effusion of fibrine within the cavity of the tumour. A moderate degree of compression upon the tumour, will, in most cases, suffice to procure the cessation of this languid flow of blood through it.

An aneurism may not only continue to pulsate but to increase in size after the operation. In such cases, inflammation, suppuration, and

sloughing of the tumour supervene. The coagula within the sac are discharged, the suppurating cavity is filled with granulations, and if the patient's health can support the discharge, cicatrization of the wound, and a perfect cure of the disease, may take place. Hæmorrhage under such circumstances rarely occurs, both extremities of the arteries being plugged up with fibrine, in the same manner as blood-vessels are found in the neighbourhood of mortified parts.

In the records of operations for aneurism, a considerable number of cases will be found where the limb has mortified; and this may have been occasioned either from some obstruction to the collateral circulation, or in some cases from the large bulk of the aneurism, causing a stagnation of blood in the smaller vessels, and capillaries. In general, however, when gangrene does occur, it is limited to small portions of the extremities, the fingers or toes, for instance, or the parts that have been too much subjected to pressure. Phlyctenous patches, followed by circumscribed eschars are also sometimes observed. The limb, under these circumstances, is benumbed, its sensibility is blunted, or a pricking sensation is felt more or less extensively. If the gangrene be limited, the sloughs are detached, and the sores heal, according as the collateral circulation becomes more and more fully established. When it extends to the whole limb, the surgeon should wait till its ravages are fairly circumscribed, before resorting to amputation.

But by far the most alarming event which can happen after the operation, is *hæmorrhage* from the wound, an event which may in general be averted, but which, when it does occur, is fraught with danger. The numerous methods which have been attempted to improve the mode of applying the ligature, have all had the important object in view of diminishing the risk of secondary or consecutive hæmorrhage, and in the present advanced state of surgery, if a judicious treatment of patients previously and subsequently to the operation be duly attended to—if the case be a proper one for adopting the measure, and the operation in all respects well executed; under such favourable circumstances, there will be little danger of secondary hæmorrhage. It may happen, however, that, from some constitutional peculiarities which could not be foreseen, the wound does not heal by adhesion, but suppurates, sloughs, and exposes the artery to ulceration; or the coats of the vessel may not be in a sound state, and will not adhere at the place where they are brought into contiguity by the ligature, so that when it comes away, hæmorrhage ensues, or, what is the most serious of all accidents, the noose may happen to be placed so close to a collateral branch, that there is not sufficient room for the blood to stagnate and coagulate for forming a plug to stay the current of the blood. From any of these causes a hæmorrhage may ensue; the blood may flow either

from the cardiac or from the capillary orifice, or it may occur from both at the same time. When the blood flows from the capillary orifice, it issues with much less impetuosity, and the blood itself has much more the appearance of venous blood than when it bursts from the cardiac orifice.

A vigorous depletive system will, I am convinced, in most cases, ensure the healing of the wound by adhesion; but when suppuration does take place, whether from such depletion not having been properly attended to, or from the soft parts around the artery having been too much displaced and injured by the operation, every effort should be made to promote the growth of healthy granulations in the wound, by the ordinary local treatment, as well as to correct, as far as possible, any disturbance of the general health. Above all, essential benefit may, under such circumstances, be derived from the use of either of the sulphates of quinine or iron, and the mineral acids; the nervous system ought to be soothed and the circulating organs tranquilized with colchicum and narcotics.

If, from the progress of the ulceration in the wound generally, or of the artery at the place of the ligature, a hæmorrhage actually takes place, serious apprehensions may be entertained of the result of the operation, and the treatment to be adopted requires the greatest promptness and decision. The first impulse of the bystander, when a jet of blood comes from the wound, is to employ pressure, and, if the wound be sufficiently large to admit the finger, the most manageable and effectual mode of applying it, is by placing the point of the finger, either with or without a small thick dossil of lint, on the bleeding orifice, employing only such degree of pressure as is necessary to arrest the hæmorrhage until further means can be obtained. If the blood flows from the capillary orifice, a much less degree of pressure will be found necessary to stem it, than when it flows from the orifice on the cardiac side of the ligature. The moment the flow of blood is controlled, all dressings and bandages should be dispensed with, and the trunk of the patient's body exposed to a cool, though not chilling air. Mental tranquillity is almost equally as essential, the slightest mental emotion increasing the action of the vascular system. Hence all appearances of fear and alarm ought to be particularly guarded against by the attendants, and a large dose of opium, alone or combined with calomel, should be exhibited. The subsequent means to be employed, those which have for their object permanently to arrest the bleeding, are now to be considered, and these must be modified according to the cause of the hæmorrhage, as well as to the particular vessel on which the operation has been performed, and likewise to the orifice, whether the capillary or the cardiac, from which the blood may have made its escape. If the hæmorrhage has been caused by a collateral branch betwixt the aneurism and the heart,

preventing the formation of a coagulum or internal clot of sufficient length to plug up the canal of the artery above the ligature, then it may be advisable to place an additional ligature on the artery, between the collateral branch and the heart, provided such a measure be practicable from the seat of the aneurism, and likewise from the superior part of the vessel not having another collateral branch so near as to render it injudicious to resort to a second operation. When, for example, a ligature has been placed on the trunk of the common femoral artery, I have known hæmorrhage to take place in consequence of the proximity of the noose of the ligature to the circumflex ilii, and epigastric arteries, there not being sufficient room left for a coagulum to be formed between the ligature and these branches; in such a case the patient's life can be saved by securing the external iliac. In one case, an experienced surgeon tied the superficial femoral artery close to the profunda, intending to place the ligature on the common trunk of the femoral artery—and the patient died from hæmorrhage. The same error was committed by another surgeon.

When secondary hæmorrhage has arisen in consequence of the diseased state of the coats of the artery at the place where the ligature was applied, preventing their adhesion, and causing their ulceration, then it may also be considered, how far it may be worth while to risk another operation, and place a second ligature on the artery at a place where its coats are supposed to be sound. In other cases of a similar description, the propriety of amputating the limb, if such a proceeding be practicable, may be duly considered, and should be resorted to, when it can hold out a rational prospect of saving life.

If secondary hæmorrhage has been caused by a bad condition of the wound, and the ulcerative process has extended to the artery, then art can avail but little, and we must entirely confide to a well-directed pressure with the point of the finger on a small compress of lint, on the bleeding orifice, effected by a succession of competent assistants, along with the application of styptics, of which the most powerful is the saturated solution of alum, sulphate of copper, or the lunar caustic.

TRAUMATIC, OR FALSE ANEURISM.

The false, spurious, diffuse, or traumatic aneurism, consists in a tumour, formed by effusion of blood from a wounded artery into the surrounding cellular membrane. This species of aneurism is usually caused by the arteries being wounded by a sharp pointed instrument, the limb being pierced in an oblique direction, so that the opening in the artery not corresponding with that of the integuments, the blood, instead of escaping through the external wound, is infiltrated into the cellular membrane, adjacent to the wound in the vessel. A false aneurism has also been

in some cases formed by the fractured extremity of a bone wounding an artery; or the violence of the injury which caused the fracture, may produce also the rupture of the parietes of the artery. It has likewise been known to succeed violent muscular efforts, producing a sudden rupture of arteries, the tunics of which had been previously diseased. The effusion of blood, which arises from a ligature cutting too quickly through an artery, falls also under this designation; and even the term *false* has been applied to the second stage of the true aneurism, when a rupture of the sac has taken place. Sometimes the effusion of blood immediately follows the wound of the artery, and is diffused in an irregular manner among the soft parts; at others, the effused blood is contained in a circumscribed cavity or sac, formed also by the surrounding cellular membrane, or by the proper sheath of the artery. In the former instance, the false aneurism is said to be *diffused*; in the latter, *circumscribed*.

If the wounded artery be deeply seated, and underneath a strong aponeurosis, and the external wound is narrow, oblique, and not corresponding with that in the artery, no great hæmorrhage may take place at the time of the accident, the blood coagulating and forming a clot which prevents the bleeding. In a few days, however, the limb swells, the tumefaction commencing at the wounded part, and extending more or less gradually in different directions over the member, and this circumstance, together with the situation, direction, and depth of the wound, generally leads to the detection of the real nature of the injury.

When arteries superficially situated are wounded, ineffectual attempts to heal the wound by the application of pressure, may cause the formation of a false aneurism, by preventing the blood from making its escape through the external wound, and allowing it to be infiltrated in the surrounding cellular membrane; or the wound in the soft parts, in consequence of some movement of the limb, may be drawn away from the corresponding orifice of the artery, or the swelling of the soft parts may prevent the escape of the blood by the external wound, and thus cause it to be diffused more or less extensively amidst the surrounding parts. Sometimes a false aneurism increases at intervals; the clot of blood which had temporarily closed up the wound of the artery being detached by the force of the circulation, and thus permitting further effusion of blood. In this manner, all the parts around and below the wound become more or less speedily injected with blood. When the distension of a limb is very great, the return of the venous blood becomes impeded, and hence follow œdema, coldness, and diminished sensibility of the member, and if the integuments are greatly distended, gangrene supervenes, and extends throughout the limb, or abscesses may be formed, followed by profuse discharge of pus, and the separation of gangrenous eschars.

An aneurism arising from a wounded artery, sometimes, though rarely, undergoes a spontaneous cure; but when it does occur, the curative process is effected, as in the true aneurism, by the formation of a coagulum within the sac; and if the wound of the artery be allowed to close, or if the aperture be of greater extent and the tumour of larger bulk, the canal of the artery may be completely obliterated.

The *treatment* to be employed in cases of this kind will depend on the extent of the wound, the size of the artery, and the duration of the disease. When an artery has been merely punctured, as sometimes happens in the operations of phlebotomy and cupping, a very moderate degree of pressure, made by means of a small but thick compress placed upon the wound, will be sufficient to prevent the outpouring of the blood, and to keep the edges of the wound in contact.

If, from a similar accident, a tumour has formed by the effusion into the cellular membrane surrounding the artery, compression may be successfully employed, provided that the blood within the tumour be evacuated before the compress is applied.

It is only, however, in aneurismal swellings, caused by very small wounds, or in large wounds of the smaller arteries, that compression can be successfully employed; indeed, when ineffectual, it is often followed by bad consequences, such as inflammation of the wounded soft parts adjacent to the artery, and extensive suppurations, which render all further local means to stop the bleeding abortive; and the patient's life can be saved only by amputation of the limb, if from the site of the wound such a measure be practicable. All the other means which have been recommended for the cure of the true aneurism, by promoting the coagulation and consolidation of the tumour, ought here to be also employed.

Before resorting to more severe measures, the hæmorrhage from a wounded artery may sometimes be arrested by pressure, applied upon the bleeding orifice with the point of a finger; and if it does not succeed, pressure employed on so limited a space, and so well regulated, can never be followed by any of those bad consequences which are produced by the pressure of bandages and other mechanical contrivances. There is indeed little difficulty in applying pressure with the finger on a wounded artery in such a manner as shall cause a temporary cessation of the hæmorrhage. The external wound, if not sufficient to admit the introduction of a finger, must be enlarged, the coagula of blood infiltrated in the cellular membrane carefully removed, and when the precise site of the wound of the artery is ascertained, pressure is to be made upon it with the point of one finger, sufficient to check the bleeding, and this is to be continued hour after hour, or even for days, by employing a succession of assistants, till the risk of hæmorrhage is permanently removed. In this manner I have succeeded in stopping

the bleeding from a wounded artery of very considerable size, when, from its site and other circumstances, it would have been a severe and hazardous operation to have secured the bleeding orifices with ligatures.

At the same time that compression is employed to arrest hæmorrhage, it ought to be remembered that the formation of a temporary barrier to the flow of blood, and the subsequent adhesion of the wound, are materially promoted by a languid state of the circulation, a state which can always be induced in a requisite degree, by the abstraction of blood, or by the influence of the tartrate of antimony on the action of the heart.

When these means have failed in curing the disease, one of two operative proceedings may be now adopted, the sac of the aneurism may be freely laid open, and the two orifices of the wounded artery tied with ligatures, or a ligature may be placed on the trunk of a vessel, at a distance from the wound. To the first of these modes of operating there are several serious objections; the infiltration of the cellular membrane with blood, the displacement and sanguineous discoloration of the soft parts, and the depth of the wounded artery, while they render the operation, in many instances, extremely difficult, affect also, in a serious degree, the patient's chance of recovery; for the parts adjacent to the wound have already become inflamed, the patient's mind has been greatly excited by the circumstances attending the accident, as well as the nature of the injury, and his constitution may have sustained a great shock by a succession of harassing bleedings from the wound, and painful attempts that may have already been resorted to, for the purpose of arresting them. When the artery is superficial, it will, however, in general, be best to expose it and place a ligature both above and below the wound.

Some surgeons think that this proceeding should be adopted wherever the situation will admit of it, even when the vessels to be tied are deep-seated. Dupuytren, on the other hand, thinks that a single ligature, placed on the cardiac side, will be sufficient in most instances, especially if assisted by compression, except where the anastomosing vessels are large and numerous.

The other mode of proceeding consists in placing a ligature on the trunk of the artery on the cardiac side of the aneurism, and at as great a distance from the tumour, as the particular case will admit of. Whenever this mode of operating for false aneurism is practicable, it offers the same advantages as are to be derived from the Hunterian operation in cases of true aneurism. But arteries are occasionally wounded where it is inexpedient to tie the trunk of the vessel, as, for instance, the gluteal, and, in such cases, it becomes necessary to adopt the first mode.

It is a point of great importance, however, before any incision is made to expose the wounded vessel, that the surgeon should take

the proper steps to enable him to command the hæmorrhage during the operation.

Some doubt has been entertained as to the course which it may be best to pursue with regard to the extravasated blood: some surgeons being of opinion that it ought to be evacuated through incisions made for the purpose; others, that it should not be interfered with. It is scarcely possible to decide the point in a general manner. Small effusions may safely be left to themselves; and in large ones, the admission of air may be attended with the worst effects. The urgency of a case, however, may now and then be mitigated, and the excessive tension relieved by a partial evacuation of the effused blood, especially if it should be accumulated at one point. The practice, however, is full of hazard, and even though the wounded vessel should have been secured, affords but a slender chance against the supervention of gangrene, or the necessity of amputation.

(James Wardrop.)

VARICOSE ANEURISM.

In this form of aneurism, which is a variety of the traumatic, both a vein and artery are wounded, and a communication is thus established between them.

There is some confusion in the application of this term. By some it is taken as referring to the tumour which is sometimes formed between the wounded artery and vein; the term *aneurismal varix* being applied to the dilatation of the vein. This confusion of terms, is, however, easily avoided, the accidental intermediary tumour is simply a circumscribed false aneurism, while the dilatation produced by the diversion of the arterial current into the vein, constitutes the *varicose aneurism*.

This affection can only occur where a vein and artery of some size lie close together. It is observed most frequently at the bend of the arm, and is produced in the following manner; in the operation of phlebotomy, the surgeon, from want of due care in ascertaining the position of the brachial artery, and its relation to the vein which is to be opened, not only carries the point of the lancet through both sides of the vein, but punctures the subjacent artery. The arterial blood finds an exit through the wound, either into the surrounding cellular membrane, forming a false aneurism, or it may pass directly into the vein, forming the varicose aneurism (see fig. 74); or again, the circumscribed false aneurism of the artery may communicate with the posterior wound of the vein, in which case, a circumscribed false aneurism, and an aneurismal varix or varicose aneurism co-exist.

Varicose aneurism may, however, be produced in a variety of ways. Mr. Hodgson relates two cases, one observed by himself, in the ham, which had been caused by a pistol-shot; the other, communicated to him by Mr. Barnes of Exeter, in which the femoral

artery and vein were wounded about four inches below Poupart's ligament, by the point of a heated iron rod.

Fig. 74.



Fig. 74 presents the preparation of a varicose aneurism of the brachial artery, which had been caused by a wound inflicted with the point of a knife, on an adult; a, the cardiac; b, the capillary extremity of the artery; c, the opening of communication between the artery and vein; d d, the collateral arteries dilated, through which the blood found a passage into the vein; e, the dilatation of the vein forming the external tumour; f, the cardiac; g, the capillary end of the vein; h, the valves of the vein, which limited the extension of the tumour downwards. The parietes of the vein were extremely strong, apparently fibrous, and four or five times their natural thickness. All the veins in the upper part of the limb were greatly, but uniformly dilated. The arrow-points indicate the direction of the current of the blood.

Larrey of Toulouse saw a case of varicose aneurism, which had been occasioned by a sabre wound of the popliteal vein and artery. The tumour, after a few years, had attained the size of two fists, and it was deemed necessary to perform amputation, which was successful. The sac was formed by the distended vein, at the bottom of which the opening of communication with the artery was observed. The nephew of this surgeon, Baron Larrey, in his *Mémoires de Chirurgie Militaire*, relates a case of varicose aneurism of large size, caused by a sabre stab: part of the attachment of the sterno-mastoid muscle was divided with the anterior scalenus, the subclavian artery and vein were wounded deep under the clavicle, and probably also a portion of the brachial plexus.

Dupuytren observed a case at the Hôtel-Dieu below the middle of the thigh, which had been caused by a deep stab made with a shoemaker's knife; and Breschet who describes this case, in his memoir, also speaks of another in which a communication existed between the common carotid and external jugular vein. This is perhaps the same case, that has since been described in the *Journal Complémentaire des Sciences Médicales*, by M. Williaume, Surgeon of the Military Hospital at Metz, and which was caused by a sword stab just above the clavicle. Sanson had a case in which, from a gun-shot wound, a varicose aneurism was produced in the subclavian vein.

It would appear, therefore, that although the puncture with the lancet in bleeding is the most common cause of this form of aneurism, it is by no means the only one. Varicose aneurism has even been known to occur spontaneously. Mr. Syme of Edinburgh has related in the *Edin. Med. and Surg. Journal*, July, 1831, an account of a case, in which a communication had been formed between the aorta and inferior cava; so that, as we sometimes see the true aneurism converted into a diffuse aneurism by the sudden bursting of the sac, so also do we find, as in this instance, a varicose aneurism formed without any wound, the communication having been formed by ulceration of the coats of the vein and artery at the point where they were in contact.

But from whatever cause the disease arises, the effect is the same: the limb feels colder, from want of its accustomed supply of arterial blood, a large portion of which being diverted in its course towards the capillaries, flows into the vein, and returns to the heart without proceeding beyond the point of communication between the vein and artery. Breschet thinks that the current of the arterial blood into the vein, may alternate with that of the venous blood into the artery, an opinion which he thinks proved by the feeling of numbness and cold in the limb, the muscular debility and impaired sensibility, and the singular transformation which the artery undergoes, becoming enlarged and tortuous below the point of communication, and its coats soft, and pliable, like those of the veins.

Varicose aneurism never makes its appearance after the infliction of the wound. The compression which is generally employed to arrest the bleeding from the external wound, causes an adhesion of the superficial wound of the vein, but the wounds of the vein and of the artery remain open or are closed only by a temporary coagulum, which, when the compression is removed, and the natural force of the circulation is restored, becomes detached, and the aneurism then makes its appearance.

There is seldom any difficulty in distinguishing the varicose aneurism. A pulsating tumour, of an ovoid shape, makes its appearance after a wound of a vein placed over the transit of an artery; the pulsations are synchronous with those of the pulse, and there is

likewise a tremulous motion and hissing sound in the swelling. William Hunter, who was the first to ascertain the real nature of this affection, in 1757, describes this noise to be such as would be produced by "a blast of air passing through a small hole." The varicose aneurism is not a disease of a dangerous character, and usually causes but little inconvenience; in most cases, particularly where the disease has occurred in the neck or superior extremities, the tumefaction of the vein is not very considerable, and remains stationary when the vein becomes distended as far as its coats will permit. The return of the venous blood from the capillary side of the tumour gradually becomes more easy, and in this state the patient may experience little inconvenience during the remainder of his life. Dr. Hunter had seen a case in which no change had occurred for thirty-five years.

Fig. 75.

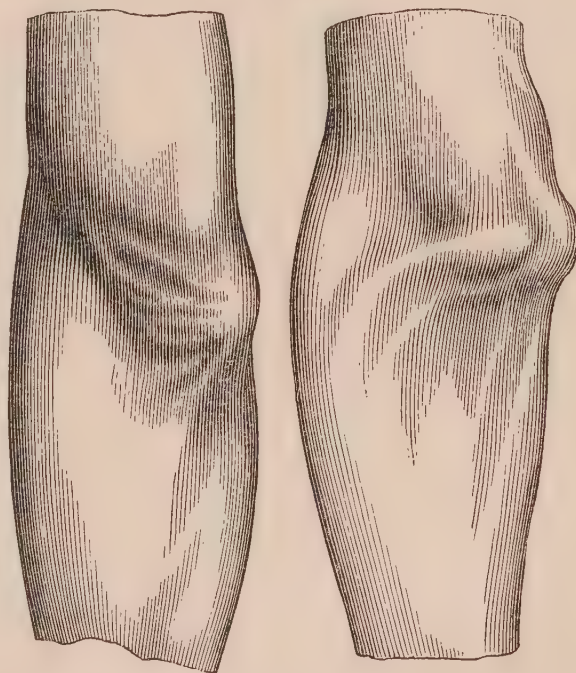


Fig. 75 represents two drawings of varicose aneurisms at the bend of the arm, taken from casts in the Museum at Guy's Hospital.

In general, the tumour remains stationary, disappearing entirely when pressure is made on it, and re-appearing as soon as it is taken off. If pressure be made on the artery above the communication, the pulsations or tremblings in the tumour cease, and it begins to diminish in size; it also diminishes when the arm is raised, and augments when the arm is held down.

There have been cases, however, where a varicose aneurism has continued to increase in volume, and where the subcutaneous veins have become so distended, and the limb so swelled, that it has been thought expedient to tie the trunk of the brachial artery.

Treatment:—In general, gentle support of the tumour, will suffice to keep it in a stationary condition. In some cases, however, it has happened, that the distension of the veins has augmented to such a degree as to determine a necessity for operation. The applica-

tion of the Hunterian operation in these instances has not been encouraging. Dorsey of Philadelphia, mentions a patient who had been wounded in the leg with buck-shot. After the wound had healed, a varicose aneurism was observed, which continued to make progress. Twelve years after the accident, the veins were greatly distended from the toes to the groin; there was pain in this region, and some ulcers situated on the foot and ankle could not be healed. The enormous distension of the vessels of the leg, and the uncertainty of finding out the communication between the artery and vein, induced Drs. Physick and Wistar to tie the femoral artery. Gangrene soon ensued, and the patient died of hæmorrhage from a distended vein, which recurred even after the vein had been tied. The whole trunk of the femoral artery was found preternaturally dilated; all the veins were greatly distended, and a bougie could readily be passed from the popliteal, into the posterior tibial artery, which participated in the dilatation; and from the latter artery the instrument could be passed into the vein, through a cyst, situated on the inside of the leg, just below the knee.

In a case, in which Mr. Atkinson of York thought it necessary, on account of the large and increasing size of the veins, to take up the brachial artery, mortification of the limb ensued.

"A young man had an aneurismal varix at the upper and inner part of the arm from a wound of the brachial artery and vein. The hæmorrhage, which was great, was arrested by compression; but, singular to relate, the hand and fingers were drawn into fixed and involuntary flexion. In the course of six weeks, the stiffness of the wrist and fingers wore off, but the patient perceived pulsations in the situation of the cicatrix, synchronous with those of the pulse, and accompanied with the peculiar hissing noise. About two years after, a soft fluctuating tumour of the size of a small hen-egg, formed in the same situation, the pulsations became more distinct, and the hissing noise could be heard in the neighbouring veins, which became greatly dilated. Upon raising the hand, the symptoms were less apparent, and disappeared when compression was made on the artery above the tumour: they persisted, without being either increased or diminished, when compression was made below the tumour. Although the patient experienced no particular inconvenience, he was anxious about it, and consulted Dupuytren, who seeing that it was a case of false aneurism, complicated with varicose aneurism, placed a ligature above the tumour only, acting on the supposition, that as compression below the tumour produced no change in the state of the disease, it would be useless to place one in that situation. The pulsations of the aneurism ceased at once; but notwithstanding that every precaution was taken in isolating the artery, to avoid including any nerve in the ligature, the fingers became cold and in-

sensible, and the forced flexion of the hand and wrist returned. A slight hæmorrhage occurred on the fourth day, and the ligature came away on the 13th, the wound healing soon after. The hand and fingers, however, remained flexed; and some time after, notwithstanding that compression had been kept up, the pulsations and hissing noise returned, the tumour enlarging, and the veins becoming more dilated. The collateral arteries had acquired very considerable size, and when compression was made on the artery at a short distance below the point where the ligature had been applied, all the symptoms of the disease disappeared. This circumstance showed the propriety of applying a second ligature, a course which, unfortunately, was not adopted, and the arm was amputated."¹

In the case from which the sketch, Fig. 74, was taken, a single ligature had been placed on the artery above the opening by which it communicated with the vein. The limb, however, wasted, the nails became detached, and it was ultimately found necessary to amputate the arm. In two cases operated on by Breschet, according to the Hunterian method, the disease returned; in both these cases, a second ligature was placed below the point of communication, and the patients recovered without any bad symptom.

To these, other cases might be added, in which the application of a single ligature had failed; the tumour re-appearing soon after, or the limb perishing from gangrene.

The analogy of the varicose aneurism with the false aneurism, is by no means so close as to justify the inference, that because a single ligature will be often found sufficient in the latter, it should be equally so in the former. In the false aneurism, and especially when a sac has been formed in the sheath of the artery or the surrounding cellular tissue, either the opening becomes plugged up with a coagulum long before the collateral vessels have opened a free course for the return of the blood into the lower part of the vessel, or when it arrives there, its current is too feeble to break up the barrier opposed to it, by the coagulated contents of the sac. In the varicose aneurism on the other hand, the communication between the artery and vein is still kept up, by the small quantities of blood that continue to pass from the vein to the artery, until such time as the augmented collaterals restore the current from the artery to the vein, in the same force as before the ligature had been applied. The return of the pulsations in the tumour, is therefore a circumstance which might be anticipated in cases of this kind, where only one ligature had been placed on the artery above the communication. But how is the supervention of gangrene to be accounted for in these instances? Perhaps it may be a consequence of the mixture of the venous with the arterial blood, this blood subsequently circulating to the

¹ Sabatier, Méd. Operat. nouvelle edit. t. iii. p. 189.

extremity of the limb. In one of the cases, in which Breschet successfully placed a ligature below the point of communication, he affirms, that on exposing the corresponding orifices of the artery and vein, he actually saw the mixture taking place.

The operative process therefore which ought to be adopted, whenever operation becomes unavoidable, is the same as that which would be resorted to in false aneurism of an artery with free and numerous anastomoses, and that is, to place two ligatures, one above, and the other, below the communication. The operation will, it is true, be tedious and difficult, on account of the altered condition of the cellular tissue, and the changed appearance which the parts will have assumed, but it is the only one on which the surgeon can rely with any degree of certainty. In placing the ligatures, the lower one should be the first tied; if the surgeon were to proceed otherwise, he would throw away the assistance which the pulsations would afford him in discovering the lower part of the artery.

The various other modes, that have been proposed to effect the obliteration of arteries, will be noticed under their respective heads, ARTERIES, HÆMOSTATICS, TORSION, &c.

PARTICULAR ANEURISMS.—SUPERIOR EXTREMITY.

In operating for aneurism, the surgeon ought to secure the attendance of assistants in sufficient number; and to these should be confided the care of laying in proper order, tourniquets, pads for compressing the arteries, straight and curved-edged bistouries, forceps, blunt-pointed scissors, blunt retractors, flexible directors, aneurism needles, ligatures, sponges, cold and tepid water, and whatever else may be deemed necessary.

Aneurismal tumours in the hand, notwithstanding the size of the trunk of the palmar arch, are extremely rare, and occur mostly from wounds, in which case the tumour is formed from extravasation. When the disease has arisen spontaneously, it may be treated successfully, either by compression, or by the ligature of the radial or ulnar arteries, or of both arteries successively, if the first ligature has not had the desired effect. Guattani saw a case of this kind, in which the tumour was as large as an orange, and situated at the base of the hypothenar eminence. When blood is effused amidst the surrounding parts, in consequence of a wound of the artery, it may be possible through the wound to reach the mouth of the bleeding vessel, and secure it. When this cannot be accomplished, and compression does not succeed, the ulnar artery may be tied, at the lower part of the fore-arm, or the root of the superficial palmar arch itself may be laid bare, by making an incision of the length of an inch and a half, extending from the radial side of the pisiform bone, towards the interosseous space between the annular and little fingers. In this situation the artery runs between two veins, the ulnar nerve lying to its ulnar side.

The subcutaneous cellular tissue of this part of the palm contains a good deal of granular fat, which juts out of its cells as soon as the incision is made: this must be held aside or removed, in order to bring the vessel into view. A needle armed with a ligature is then passed under the artery from the ulnar to the radial side (see No. 4, fig. 77). This operation is neither so simple, nor so easily performed, as that of tying the vessel at the lower part of the fore-arm; and, as incisions in the palm of the hand ought to be avoided as much as possible, the latter operation, under all ordinary circumstances, ought to be preferred.

The radial artery is also accessible on the back of the hand, where it is about to form the deep-seated palmar arch. The objection to the incision on the hand does not apply to this region. The operation, owing to the superficial situation of the vessel is not difficult, and is performed as follows: The fingers being held straight, and the thumb thrown strongly into extension, the two tendons of the abductor magnus, and extensor longus are rendered prominent. In the depression between them, the artery will be felt pulsating, in the cleft between the posterior extremities of the two first metacarpal bones, close upon their capsular ligaments. After the division of the skin, the cephalic vein, and a branch of the radial nerve are exposed; beneath there is an aponeurosis which conceals the artery; this should be divided on a director. The vessel is then isolated, and the ligature being placed beneath, is tied.

Fig. 76.

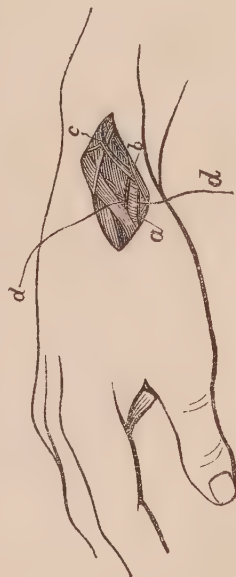


Fig. 76. *a*, the artery; *b*, the radial nerve; *c*, the cephalic vein; *d d*, the ligature passed under the artery.

Both the radial and ulnar arteries however, are more frequently tied above the wrist for aneurismal tumours, or traumatic extravasations in the palm of the hand. In some instances, where the hæmorrhage has returned after the ligation of one of these vessels, the other has been also secured. Some very eminent authorities state, that this proceeding may in general be dispensed with, as the compression of the second vessel, conjointly with the ligation of the first, will effect a cure.

ARTERIES OF THE FORE-ARM.

The fore-arm is supplied by three arteries, the radial and ulnar, derived from the bifurcation of the brachial at the bend of the arm, and the interosseous, derived from the ulnar.

Radial artery, above the wrist.—The fore-arm being presented in supination, and the pulsations of the artery being felt, a longitu-

dinal incision, from an inch and a half to two inches in length, is made in the direction of the vessel. This incision, which divides only the skin and cellular tissue, and runs between the tendons of the supinator radii longus, and palmaris longus, terminates within half an inch of the wrist-joint. This exposes an aponeurosis, which being carefully divided on a director, the artery presents itself to view, between two veins; the radial nerve lies at some distance to its outside. In isolating the artery, it should not be detached from its connexions to a greater extent than is necessary for passing the ligature beneath it. It may be raised indifferently from without, inwards, or from within outwards. (See No. 2, fig. 77.)

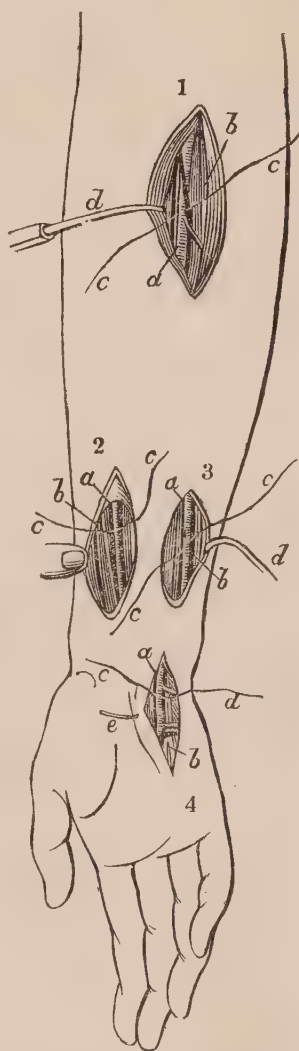
Fig. 77.

Fig. 77. No. 1, *a*, the ulnar artery, the black lines indicating the veins at each side of it; *b*, the ulnar nerve; *c c*, the ligature passed under the artery; *d*, a blunt hook.

No. 2, *a*, the radial artery, the black lines on each side of it representing the veins; *b*, the radial nerve; *c c*, the ligature, lying across the wound.

No. 3, *a*, the ulnar artery, the black lines on each side of it representing the veins; *b*, the ulnar nerve; *c c*, the ligature lying aslant the wound; *d*, a retracting hook.

No. 4, *a*, the ulnar artery, its accompanying veins represented by the dark lines at each side of it; *b*, the ulnar nerve; *c d*, the ligature passed under the vessel; *e*, a blunt hook retracting the radial edge of the incision.



Ulnar artery, above the wrist.—In this region, the ulnar artery lies on the flexor profundus, covered by its own aponeurosis, the tendon of the flexor carpi ulnaris, the subcutaneous cellular tissue and skin. An incision of the same length, and parallel to that for the operation just described, lays open the skin and adipose tissue; the tendon is drawn away towards the ulnar edge of the fore-arm, and the aponeurotic sheath covering the artery carefully divided, on a director. The artery is thus brought into view, lying between its two accompanying veins, the ulnar nerve being a little behind, and to its ulnar side. (See No. 3, fig. 77.) The ligature is passed beneath the artery from the ulnar to the radial side.

Ulnar artery at the upper third of the fore-arm.—The ulnar artery crosses from the point of bifurcation of the brachial, covered by the fleshy mass formed by the muscles arising from the inner condyle of the humerus. At the junction of the upper and middle thirds of the fore-arm, where it first becomes accessible for the ligature, it reposes on the flexor profundus, covered by the sublimis, and flexor carpi ulnaris. In this course, it corresponds with a line drawn obliquely from the middle of the bend of the arm, to the junction of the upper and middle thirds of the fore-arm; from this point, it proceeds in nearly a straight line, down to the radial side of the pisiform bone.

Its anomalies, however, are not unfrequent, and it will now and then be found running more superficially, or nearer to the radial. A vertical incision from two to three inches long, commencing about three fingers' breadth below the bend of the arm, is made in the cellular line that separates the flexor sublimis from the flexor carpi radialis. This line, being divided, the muscles superficial and deep-seated, are separated with the fingers, or the handle of the bistouri. The artery, with its two accompanying veins, is thus exposed; the nerve is on its ulnar side, and more superficial. (See No. 1, fig. 77.) The needle should be introduced from the ulnar side, between the nerve and artery. At this step of the operation, the fore-arm should be slightly bent.

Radial artery at the upper third of the fore-arm.—As we ascend the fore-arm, both the radial and ulnar arteries become deeper seated, and this arises, in consequence of the muscles which terminate in tendons below, being thick and fleshy above. A line drawn from the middle of the bend of the arm to the inside of the styloid process of the radius, will give a tolerably correct idea of the course of the radial artery. In the upper third of the fore-arm, it lies on the flexor profundus, covered by the flexor sublimis, and flexor carpi radialis. The incision should be at least two inches long, beginning about three fingers' breadth below the joint, and should be carried obliquely in the line of the artery and along the ulnar edge of the supinator radii longus. If the superficial radial vein run in the line of the incision, it should be carried to the radial side of the wound. On dividing the skin, the aponeurotic line that unites the flexor sublimis and flexor carpi radialis, is exposed to view. These muscles are separated, and the long supinator being raised, the aponeurosis covering the artery is seen. This being divided on the director, the artery with its satellite veins is seen, having the radial nerve a little to its radial side. (See No. 4, fig. 78.) The needle is passed under the vessel from the ulnar to the radial side; if the hand and fore-arm be bent, this step will be facilitated.

In operating for traumatic aneurisms in the fore-arm, the ligature should be placed as near the wound of the vessel, as circumstances will allow; as otherwise, from the number of

branches given off from the main arteries, the blood might find easy access to the aperture of the wounded vessel.

BRACHIAL ARTERY.

The brachial artery may be tied at the bend of the arm, or in its middle or upper part. The course of the vessel corresponds with a line drawn from the middle of the bend of the arm upwards along the inner edge of the biceps, which covers it a little, until it nearly reaches the axilla. At the articulation itself, its course is marked pretty accurately by the median basilic vein, which is visible beneath the skin. Anomalies occur frequently in the distribution of this vessel; the most common is that in which its bifurcation occurs, at various points of its course, from the bend of the arm up to the axilla. As its superficial situation, however, allows of its pulsations being felt throughout its entire course, the surgeon can easily ascertain beforehand, whether such is the case or not. (See fig. 78.)

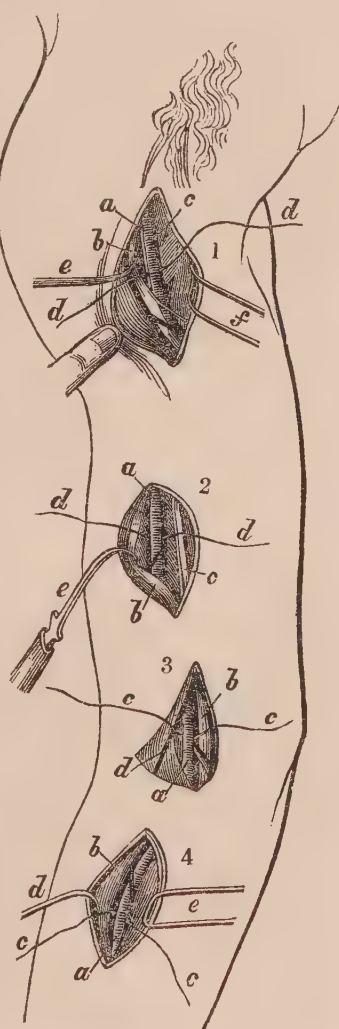
Fig. 78.

Fig. 78. No. 1. *a*, the axillary artery; *b*, the median nerve; *c*, the axillary vein; *d*, the ligature passed under the artery; *e* and *f*, a blunt hook, and retractor.

No. 2. *a*, the brachial artery, the dark lines at each side of it indicating its accompanying veins; *b*, the median nerve; *c*, the internal cutaneous nerve; *d*, the ligature passed under the artery; *e*, blunt hook retracting the radial border of the wound.

No. 3. *a*, the brachial artery, the dark lines indicating the satellite veins; *b*, the median nerve; *c*, the ligature passed under the artery; *d*, the median basilic vein.

No. 4. *a*, the radial artery, the dark lines indicating its satellite veins; *b*, the superficial vein running along the entire length of the radial border of the incision; *c*, the ligature passed under the artery; *d* and *e*, a hook, and retractor.



At the bend of the arm.—In operating, the fore-arm being extended in supination, and the surgeon standing between it and the patient's body, he makes an incision from two to three inches long, in the direction of the artery, beginning above and terminating in the middle of the bend of the arm. The median basilic vein is left untouched on the radial border of the wound. Its lips are kept asunder

by an assistant, and the brachial aponeurosis, which is continuous with the tendon of the biceps, is divided on a director. The artery is now seen accompanied by its two veins, one on each side, and having, on its ulnar side, but at some little distance, the median nerve. (See No. 3, fig. 78.) The fore-arm is now bent a little, in order to facilitate the isolation of the vessel, and the ligature is passed beneath it from the ulnar to the radial side.

Aneurismal tumours in this situation are by no means uncommon, but they are chiefly of the traumatic kind, produced by the sword, or by the lancet in bleeding. Their treatment by compression is not unfrequently successful. When an operation is required, great care should be taken to distinguish the artery from the nerve; a task which it will be sometimes difficult to accomplish, on account of all the parts being deeply tinged by the extravasated blood. In these cases the surest plan, when practicable, will be to place a ligature both above and below the wound of the artery.

At the middle of the arm.—The indications of the course of the vessel in this situation, are the inner border of the biceps, a line drawn obliquely from the middle of the bend of the arm, to that of the hollow of the axilla, or its own pulsations. The median nerve, which accompanies the artery throughout its entire course, here crosses obliquely in front of it, and is thus at its radial side above, and at its ulnar side below. (See No. 2, fig. 78.)

The arm is held in the same position as in the preceding operation, and an incision of two, or two and a half inches in length is made, in the direction already described, beginning below, if it be the left arm, and above, if it be the right. The finger of the left hand is now introduced into the wound to feel for the median nerve, which presents itself as a thick, white cord, and the artery which pulsates behind it. The median nerve and biceps being retracted with a blunt hook, the firm aponeurosis enveloping the artery, and the two veins, with which it is usually accompanied is exposed. This should be divided on a director; the artery is then seen, with its veins covering, or at each side of it, and the internal cutaneous nerve on its ulnar side; the ulnar nerve itself lies about half an inch farther back. The cellular envelope of the artery is then opened with the nail or blunt-pointed instrument, and being fairly isolated, a needle is passed beneath it from the radial to the ulnar side. The only difficulty that can arise in the execution of this operation, will depend on an anomalous distribution of the vessel: when the pulsations of the artery cannot be felt, the median nerve will serve as a guide to it, as it will be found just behind it,

At the upper part of the arm.—The artery, in this part of its course, is situated to the inside of the edge of the coraco-brachialis, and a little lower down it begins to be covered with the biceps. (No. 1, fig. 78.) The operation is performed as in the preceding instance.

Compression is also successful in curing aneurisms of the brachial artery, for which the humerus offers a ready point of opposition; and when it does not cure, it retards their progress, or renders them stationary. Winter cured the queen of Bavaria of an aneurism of the brachial artery, by compression, and Lisfranc relates the case of a person who has had four aneurismal tumours in the course of this vessel, the progress of which has been staid for more than a year, by means of a laced sleeve.

In placing ligatures on the arteries of the fore-arm, and arm, the supply of blood to the parts from which any of the main branches is cut off, is sufficiently assured by the great number of minor branches that pass off from them in their course. Thus, when the brachial artery is tied at the bend of the arm, the circulation is carried on between it and the arteries of the fore-arm, by the anastomosing circles, that are distributed above and below the condyles. As regards the nourishment of the inferior part of the limb, therefore, no apprehension need be entertained; but, on the contrary, this communication may be so free, as still to allow the blood to arrive in the wounded vessel, or aneurismal tumour, and thus render it necessary to place another ligature, or to have recourse to compression.

When the brachial artery is tied higher up, the circulation is carried on in the same manner, by the circumflex, the profundus superior, the muscular branches, and by the great anastomotic, when it has been spared; and it is in order to save this collateral circulation, to as great an extent as the disease will allow, as well as to prevent the tumour from being supplied with blood through these channels, that it is recommended, in operating for these aneurisms, to apply the ligature as near the tumour as circumstances will admit of.

AXILLARY ARTERY.

As the frequency of aneurism is relative to the size of the arterial trunk, or its exposed situation, its occurrence in the axilla idiopathically, or from wounds, is not unfrequent. The axillary artery runs in an oblique course, from the lower edge of the clavicle, or from that of the first rib, to the point where it emerges from the hollow of the axilla. At its commencement it lies deep under the clavicle, covered by thick muscles; at its termination, its pulsations can be easily felt within the border of the axilla, where it is covered by the skin, the axillary vein, the median nerve, and its two roots, which mask, or rather envelope it. Throughout this course, it is accessible to the ligature, at three different points. In the first, or uppermost of these, which extends from the clavicle to the edge of the pectoralis minor, the artery is bounded, on its inside, by the walls of the thorax, and serratus major, on its outside by the coracoid process. A triangular space is thus formed which is filled with the strong cellular tissue that envelopes the vessels and nerves, and co-

vered by the pectoralis major, and deltoid. The relative situation of the vessels and nerves in this space is as follows: the axillary vein, a vessel of considerable size, and the first root of the median nerve, partly conceal the artery, the vein lying to the thoracic, the nerve to its scapular side; the artery lies between, and, at the same time, behind them. Before passing under the pectoralis minor, the artery gives off its acromial and external thoracic branches, and the axillary vein receives the cephalic vein with several other branches which pass in front of the artery, and with these also, several small nerves from the great plexus are mingled. The artery emerging from beneath the pectoralis minor, and continuing its course outwards, enters another space, which is bounded by the lower border of the pectoralis minor, posteriorly by the subscapularis muscle, and inferiorly by the border of the axilla; in this course the vein gradually gets from the front to the inside of the artery, and the nerves which had surrounded it almost completely, begin to separate from it; the two roots of the median, which had been in front of it, pass, one to its radial, the other to its ulnar side; the external cutaneous nerve lying on its radial side, the radial and circumflex receding from it behind; branches of veins here empty themselves into the great venous trunk, and the whole is enveloped in the celulo-fibrous tissue already alluded to, while numerous glands and fat fill up the space towards the thorax. On passing from the edge of the subscapularis, the artery runs parallel to the edge of the coraco-brachialis, till it assumes the name of brachial.

Fig. 79.

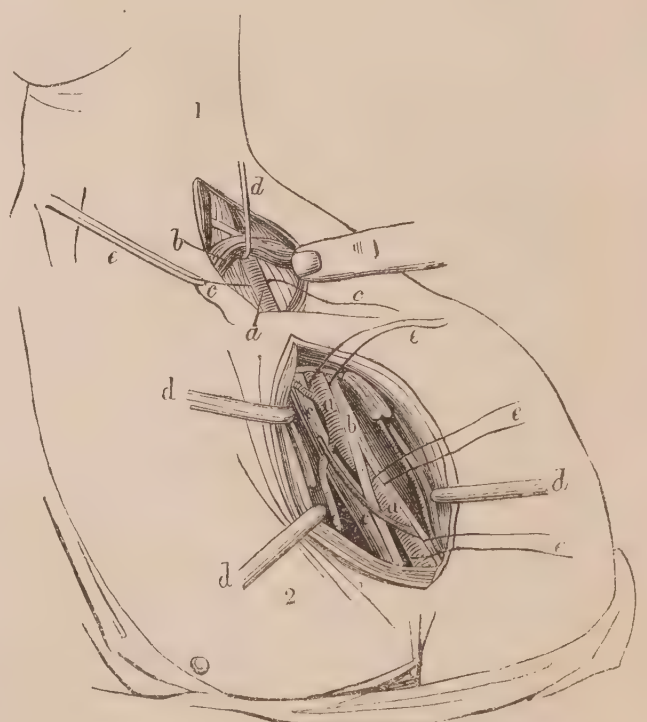


Fig. 79. No. 1 represents the ligature of the subclavian artery between the scaleni muscles. The external jugular vein is retracted with the external border of the wound. The anterior scalenus lies to the inside, and the nerves of the brachial plexus to the outside of the artery. *a*, the subclavian artery; *b*, a transverse cervical vein raised with the omo-hyoideus on a blunt

hook, *d* ; *c c c*, the ligature passed beneath the artery, and still held in the eye of the needle.

No. 2. Shows at one view, the three several points upon which a ligature may be placed on the axillary artery ; viz., just below the clavicle, below the pectoralis minor, and within the border of the axilla. The external border of the wound is formed by the deltoid, which is retracted. The internal, by the axillary margin of the pectoralis major. The pectoralis minor is divided, and its remnants are seen in both the borders of the wound at its upper part. *a a*, the axillary artery, giving off the acromio-thoracic and long thoracic arteries ; *b*, the median and musculo-cutaneous nerves ; *c c*, the axillary vein, receiving the cephalic vein, which dips down to it, crossing the axillary artery, with the deltoid branch of the acromio-thoracic artery at the upper angle of the wound ; *d d d*, retractors ; *e e e*, the three ligatures placed at different points of the artery.

Ligature of the artery in the axilla.—The patient being placed in the recumbent posture, and the arm raised, the pulsations of the artery are felt ; the skin is then divided along its course, to the extent of two inches or two and a half ; the incision commencing above, and running longitudinally, at about half an inch within the anterior border of the axilla. In this manner, the knife falls on the edge of the coraco-brachialis, and this is a point of some importance, as leading to the median nerve ; this being found, the artery lies to its inside, and beneath it. If any of the other nerves should happen to be mistaken for the median, the indication, of course, will be fallacious. For the details of this operation, see No. 1, fig. 78, and the lowest of the three ligatures marked *e*, fig. 79.

The incision of the skin exposes the fascia and cellular tissue, which must be carefully divided on a director. The arm is then lowered a little, the median nerve is held to the radial side by means of a blunt hook, and a needle is passed under the artery, which is cautiously isolated from the internal cutaneous, radial, and ulnar nerves, and the axillary vein. From the moment the plexus comes into view, the knife should be laid aside, and the operation completed by means of a blunt blade of silver, or ivory.

This operation may be resorted to in cases of aneurism of the upper part of the brachial artery, or in cases of wounds of the lower part of the axillary vessel itself. John Bell mentions a case in which the axillary artery was divided with a scythe ; the hæmorrhage ceased from syncope, and Hall seized the upper division of the vessel through the wound, and tied it. Maunoir of Geneva treated another case of a sabre wound of the artery by enlarging the wound from the axilla, and placing a ligature, both on the upper and lower divisions of the vessel.

While the question of the value of Brashdor's method remained undecided, it might have been expected that its application to aneurisms of the axillary artery, which gives off such a number of minor branches in its course, would meet but little encouragement. Velpeau, however, hints, that if there was sufficient space between the aneurismal tumour and the giving off of the circumflex and

scapular branches, that there might be a reasonable chance of success, and the ideas expounded by Mr. Wardrop, in the general article on this subject in the present work, are calculated to gain favour for such a proceeding, more especially when the aneurismal tumour is not of considerable size. It should be recollected, that the chief ground of fear in treating axillary aneurisms, by ligature above the tumour, either below or above the clavicle, consists in the extension upwards of the diseased condition of the parietes ; and that if the application of a ligature on the capillary side of the tumour failed, the resource of taking up the vessel between the tumour and the heart would still remain.

Ligature of the artery, below the pectoralis minor.—The course of the artery in this situation, corresponds with the cellular line which separates the pectoralis major from the deltoid ; the cephalic vein runs in this line, and will serve as a guide for the incision. The patient is placed on a bed, the head and chest raised, and the arm carried away from the trunk. An incision is then made in the muscular interstice already mentioned, from above downwards for two and a half or three inches, extending obliquely from below the clavicle, to the border of the axilla. The cephalic vein uninjured is included in the pectoral edge of the incision, and the two muscles being separated, are held apart by the assistants. The pectoralis minor is thus exposed, together with the cellular tissue which envelopes the veins, arteries, and nerves. If the finger be now passed beneath the cord which they form together, they may be drawn more fully into view. The vein distended with blood, will be discovered in front, and to the thoracic side of the artery, the artery itself is seen entering between the two roots of the median nerve, and the rest of the plexus, which lies on its scapular side. Delpech, in his case, raised the whole mass in this manner on his finger ; but this step is not necessary, as the artery can be detected, and isolated with a blunt-pointed instrument, without disturbing the parts. A curved needle is then introduced beneath the vessel, from within outwards. Before the ligature is tied, due care should be taken that no nerve is included. If any of the small thoracic arteries should impede the operator, he may tie and divide them. The tendon of the pectoralis minor itself, may, for the same reason, be cut across ; but as this must necessarily weaken the shoulder, it ought not to be done, without positive necessity. For the details of this operation, see No. 2, fig. 79, the middle ligature marked *e*.

As no one would seriously propose at the present day to operate for an aneurism in this situation, with a view to opening the sac itself, the ground on which the propriety of applying a ligature upon the middle division of the axillary artery rests, is that it spares branches that are of importance for the nutrition of the arm. It is unnecessary to allude

to the bad effects which must ensue from including a nerve in the ligature; in some of the early cases of ligature of this vessel, the failure of the operation by sphacelus, might doubtless be attributable to this cause. In Desault's case, the brachial plexus was included in the ligature, and the whole arm mortified; and in White's case, where the plexus was also tied with the artery, the same result ensued. Keate, the surgeon-general, operated for an aneurism, that had already burst, by first cutting down on the artery in this situation; but, on finding that the artery pulsated below the ligature, he placed another ligature higher up, near the first rib. Chamberlaine, of Kingston, Jamaica, operated in such a manner, as to combine the method above described, with that which is employed in reaching the vessel close under the clavicle, making one incision transversely under the clavicle, the other obliquely along the border of the pectoralis major, and everting the L shaped flap; his patient recovered in less than a month. (See No. 2, fig. 80.)

Fig. 80.

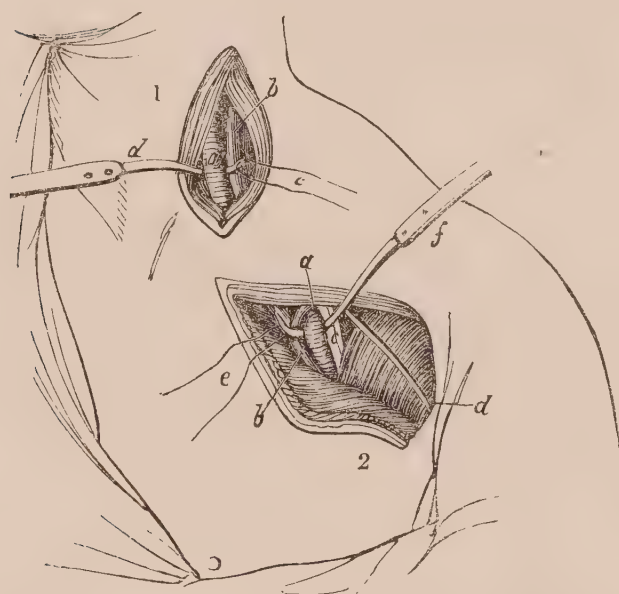


Fig. 80. No. 1. Sedillot's plan of arriving at the carotid, by cutting down between the sternal and clavicular portions of the sterno-mastoid muscle. *a*, the carotid artery, the internal jugular vein *b*, lying to its outside; *c*, the ligature in the eye of the aneurism needle, *d*, which is placed under the artery.

No. 2, a triangular wound, in the upper border of which is seen the clavicular attachment of the pectoralis major; the flap hangs down, and exposes the pectoralis minor, which is seen crossing the inferior half of the wound, the cephalic vein running upon it. *a*, the axillary artery, immediately below the clavicle; *b*, the axillary vein; *c*, the brachial plexus; *d*, the cephalic vein going to join the axillary vein; *e*, the ligature in the eye of the aneurism needle; *f*, the needle supporting the artery, which is somewhat raised upon it.

Ligature of the artery just below the clavicle.—In the triangular space already described, the artery is covered by the pectoralis major, and runs in an oblique direction from within, outwards and downwards, till it passes under the pectoralis minor, a little below its tendinous expansion. The patient being placed in the recumbent posture, on a bed or re-

clining chair, exposed to the light, the shoulder slightly raised, and the arm carried away from the trunk, Hodgson, in order to expose this part of the axillary artery, directs a semi-lunar incision, with its convexity downwards, and about three inches in length, extending from about an inch from the sternal end of the clavicle, and stopping short of the edge of the deltoid muscle, in order to avoid wounding the cephalic vein. This incision divides the skin, and fibres of the platysma myoides. The fibres of the pectoral muscle itself are then divided in the same manner and to the same extent. This dissection should be conducted carefully with a director, until it exposes the whitish layer of cellular tissue. On raising the muscle, the pectoralis minor, which forms the lower boundary of the triangle, is seen crossing the lower part of the wound. The arm should now be brought close to the side, a blunt instrument, or the finger, is employed to depress the edge of this muscle, and clear the vessel from the cellular membrane that connects it with the vein and nerves. On the thoracic side, and somewhat in front, will be found the vein, which swells at every expiration, the nerves of the brachial plexus lying to its scapular side, and somewhat behind it. The safety of the vein must be carefully looked to, and, in isolating the artery, it should be held aside with a blunt hook, and the curved needle should be introduced between it and the artery, or from within, outwards. The ligature should then be raised on the finger, before it is tied, in order to ascertain that the pulsations in the aneurismal tumour are stopped; of course the precaution should also extend to seeing that no nerve be included; and still more so, that a nerve shall not be mistaken for an artery.

Fig. 81.

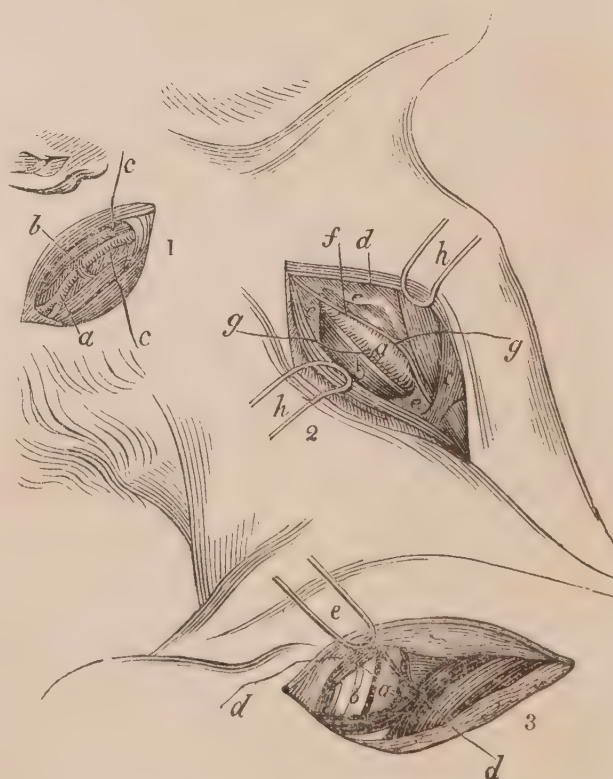


Fig. 81. No. 1. *a*, the occipital artery; *b*, the vein, with its branches crossing the artery; *c c*, the ligature passed under the vessel.

No. 2. *a*, the carotid artery; *b*, the internal jugular vein; *c*, the omo-hyoideus muscle; *d*, the external jugular vein; *e e e*, the sheath of the artery and vein, which has been laid open; *f*, the descendens noni; *g g*, the ligature passed beneath the artery; *h h*, retractors holding the lips of the wound asunder.

No. 3. *Mr. Hodgson's plan.* *a*, the axillary artery; *b*, the brachial plexus; *c*, the vein receiving the cephalic vein and other lesser veins; *d d*, the ligature passed beneath the artery; *e*, a retractor raising the convex border, or flap of the wound.

This is the usual mode of cutting down on the superior third of the axillary artery; the objection to which it is liable, on account of the transverse section of so many muscular fibres, has given origin to another method, which is an extension of the preceding one, and seems to deserve a preference; though, of course, this must depend more or less on the nature of the case requiring its application. The pectoralis major consists of a sternal and a clavicular portion, at the junction of which there is an interstice, which can be rendered still more distinct, by forcibly abducting the arm. In this line an incision of the integument is made, and the two portions of the muscle are carefully separated down to the cellular layer in contact with its under surface. The direction of this incision runs in an oblique line, produced from the outer edge of the sterno-cleido-mastoideus, beginning at the inferior border of the clavicle, at the junction of its inner, with its two outer thirds, and extending downwards about three inches. The two portions of the muscle being held asunder, the vessels and nerves are seen in the relative positions already described. The arm is then brought close to the trunk. If the space obtained by separating the two portions of the muscle should not be found sufficient to enable the operator to isolate the artery with facility, he may divide transversely some of the fibres attached to the clavicle, on a director, or with a probe-pointed bistoury. The artery is separated from the vein in the same manner, as before-described, and the ligature being passed beneath it, the operation is terminated. The hazardous dives made with the needle, which were practised in the early operations on this vessel, are now very properly condemned, and universally rejected.

After the ligature has been placed on the main trunk, although the arm does not possess the same advantages in point of supply as the thigh, it not having any vessels to correspond with the internal iliac, and profunda, still the circulation will be carried on, and sufficient nourishment afforded through the superior branches, the acromial, superficial scapular, transversalis colli, and internal mammary, all of which anastomose with the circumflex, subscapular, and internal mammary.

In operating on the axillary artery, the cutting instrument should be laid aside as soon as the cellular tissue which invests it, is exposed; the rest should be effected with the finger-nail, or a blunt-pointed instrument.

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Axillary aneurisms, like all others, have been sometimes observed to undergo spontaneous cure; but to refrain from operating at an early stage, when the chances of success are greatest, in the hope of such an unlikely result, would be mere folly. These operations are certainly difficult, and demand the utmost patience and pains-taking; any attempt at hurry or display in the performance, would be highly culpable.

SUBCLAVIAN ARTERY.

Though the course of this vessel be short, it may be tied at three different points, viz. on the first rib, to the outside of the anterior scalenus; between the two scaleni; and on the inside of these muscles.

Fig. 82.

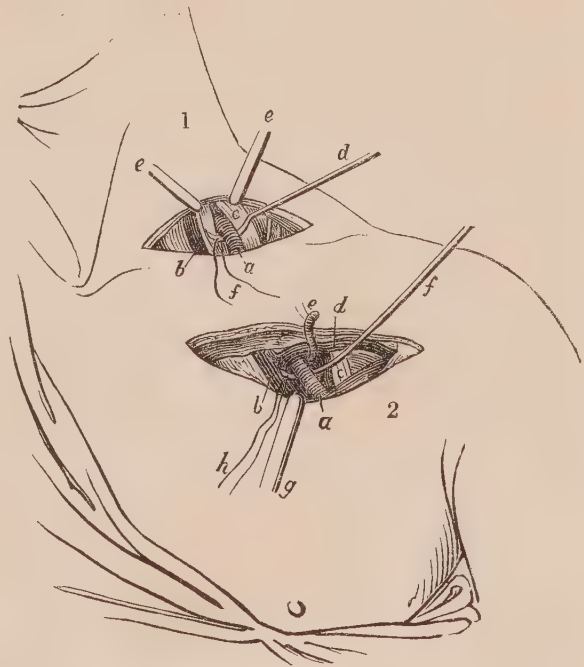


Fig. 82 represents the operation by transverse incision for placing a ligature on the subclavian artery above, and on the axillary artery below the clavicle. The shoulder is depressed, and the arm drawn away a little from the trunk; the neck is stretched, and the head inclined to the opposite side.

No. 1. *a*, the subclavian artery, raised on an aneurism needle *d*, and presenting itself between (*c*) the nerves of the brachial plexus, which lie to its outside, and the edge of the anterior scalenus, which lies to its inside, separating it from *b*, the external jugular vein, which descends behind the clavicle to empty itself in the subclavian vein; the outer border of the clavicular attachment of the sterno-cleido-mastoid is seen in the inner angle of the wound; the omo-hyoideus is raised with the upper border of the wound, and branches of nerves are seen crossing it at the external angle; *e e*, retractors; *f*, the ligature.

No. 2. In the upper border of the wound the clavicular attachment of the pectoralis major is seen divided; in the lower, the superior border of the pectoralis minor and the section of the pectoralis major are depressed. *a*, the axillary artery raised on an aneurism needle; *b*, the axillary vein receiving the cephalic vein, which crosses the brachial plexus and the artery. A branch of the thoracico-acromialis which impeded the operation, was tied, and is seen turned back upon the upper lip of the incision; *c*, the nerves of the brachial plexus; *d*, the cephalic vein; *e*, the thoracico-acromialis which has been cut and tied; *f*, the aneurismal needle sustaining the artery; *g*, a retractor; *h*, the ligature hanging from the eye of the needle.

S

At the external edge of the anterior scalenus, the subclavian artery lies deep in a triangular space, which is bounded below by the clavicle, internally by the scalenus, and externally by omo-hyoideus muscle. This space is traced superficially by the external edge of the sterno-cleido-mastoid, the anterior edge of the trapezius, and the upper edge of the clavicle. This hollow, which is defined to the eye, contains the following parts in succession from without, inwards: the skin, platysma myoides, subcutaneous adipose tissue with lymphatic ganglions, and veins; the external jugular, advancing on this space more or less, here dips down with other lesser veins to join the subclavian. The artery rests on the first rib and intercostal space, having the vein on its inside, and separated from it by the scalenus muscle, and the cervical nerves descending to form the brachial plexus on its outside and inclining behind it; above it, is seen the omo-hyoideus crossing obliquely.

The operation of cutting down upon this portion of the artery is thus performed:—the patient being placed on a bed, the head and chest raised, and the arm drawn downwards and forwards, an incision running above the clavicle, and parallel to that bone, is made from the outer edge of the sterno-mastoid to the anterior border of the trapezius. This divides the skin only; a second incision divides the cellular membrane and platysma myoides: if the external jugular vein should lie in the line of the incision, it should be carried out of the way of injury with a blunt hook: the deep-seated cervical fascia comes next, which being divided on a director, the cellular tissue that contains the lymphatic ganglions and veins already mentioned rises a little; it contains, also, two arterial branches—the transversalis colli and the transversalis scapulæ, which may require a ligature. The surgeon seeks with his left index finger in the wound for the external edge of the scalenus, which leads him at once to the artery lodged in the angle formed by its attachment to the first rib. The vessel being carefully isolated, the armed needle is passed beneath it from its inside, and the operator, after assuring himself of its effect on the aneurismal tumour, ties it firmly by means of a serre-nœud, if it should be too deep to be properly done by his fingers. This step of the operation will be facilitated by lowering the shoulder, and inclining or turning the patient's head to the opposite side. The depth at which the artery is found varies, being more superficial in the lean and long-necked. When the tumour is very considerable, this depth is still further increased by its uplifting the clavicle; owing to this cause, Sir A. Cooper was unable to put a ligature on the vessel, after he had made the necessary incisions. If the extent of the incision be too limited, owing to the clavicular portion of the mastoid muscle spreading along the bone, it has been recommended to divide its fibres to the extent necessary: others recommend the incision to be made in

the form of *L* reversed. Physick recommends a V shaped incision. If, from the great depth of the artery, the difficulty of placing a ligature upon it should prove considerable, part of the anterior scalenus may be divided; this was done in the case on which Mr. Liston operated: half only of the muscle was divided, in order to avoid all risk of wounding the phrenic nerve.

Ligature of the Subclavian Artery between the Scaleni Muscles.—In this part of the vessel's course it is free from close connexion with any important parts. The incisions are made in the same manner, with this difference only, that, internally, the border of the mastoid muscle is divided. On arriving at the outer border of the anterior scalenus, a curved director, guided on the finger, is carried behind it. This manœuvre requires great caution. The phrenic nerve runs under this muscle, and again to its sternal side are the subclavian and internal jugular vein. The index finger should, therefore, be passed under the muscle, so as to meet the director; its inferior attachment is then divided, the muscle immediately retracts, and the artery is easily discovered. If any arterial branches are distributed in front of the muscle, they should be secured before dividing it; or without waiting for this, the muscle may be cut higher up. After this section, the artery may be very easily isolated.

The majority of these operations have been performed with a transverse or horizontal incision, rendered, in the cases of Mr. T. Blizard and Dr. Post, slightly oblique. In Mr. Porter's case, the deviation from the ordinary method was more considerable, as he added to the horizontal incision a vertical one, in the line of the external border of the mastoid muscle, forming an *L* flap, which was everted. Hodgson's method for ordinary cases undoubtedly deserves the preference; but the size of the tumour, the corpulency of the patient, or other circumstances may be such as to justify the operator in modifying the method in such a manner as may best suit the nature of the case he has to treat.

Ligature of the Subclavian Artery on the inside of the Scaleni Muscles.—Here the vessel rising out of the cavity of the thorax lies close upon the spine, and covered in front by the sterno-clavicular articulation, and the insertion of the sterno-mastoid muscle. There is some difference in the arteries of the right and left side, both as regards their length and the parts with which they are connected. The left subclavian arises directly from the aorta; its lowest part is covered by the lung, and the subclavian vein, close upon the point where the thoracic duct penetrates it from behind; the carotid, which gradually recedes from it on rising from the arch of the aorta, lies to its inside, where is also the œsophagus, in front; the phrenic, and pneumo-gastric nerves pass into the chest, just before it. On the right side it arises from the innominata, and is, on that account, much shorter: on its posterior

surface it gives off the vertebral artery; the recurrent nerve here turns round its base, to reach the trachea; it is crossed in front by the phrenic and pneumo-gastric nerves; it gives off in this short course no less than six important branches, and is covered below by the termination of the internal jugular vein.

Beset with difficulties at every step, and dangers of the most formidable kind, as this operation must be, it has nevertheless been performed. Dr. Colles, of Dublin, having a case of aneurism of the right subclavian artery, in which the tumour extended from behind the sterno-clavicular articulation upwards along the edge of the muscle, and outwards to the middle of the clavicle, was bold enough to cut down upon this part of the subclavian artery: the dissection was of course tedious, and on arriving at the vessel only a very small portion of it was found to be in a healthy state; and on this, after considerable difficulty, the ligature was placed. From symptoms of oppression at the heart and dyspnoea that occurred at the moment, it was feared that the pleura had been injured, and, in consequence, it was deemed prudent not to tighten the ligature till the fourth day after. The patient continued in a tolerably quiet state till the ninth day, when he was attacked with pain at the heart, accompanied by a sense of suffocation: he died delirious, after a few hours' suffering. Both the aorta and subclavian were diseased.

The operation has not since been attempted by any other surgeon. On the dead body it is performed in the following manner: an incision is made over the clavicular portion of the mastoid, extending outwards to within an inch of the trapezius. This portion of the muscle is next divided on a director, or with a blunt-pointed bistoury. The anterior scalenus is then seen, to the tracheal side of which the pulsations of the artery may be felt. The most difficult step of the operation still remains, which is not so much the passing a ligature round the artery, as the isolating it from all the important parts that surround, or are in contact with it, at almost all points.

Whether this operation ought to be attempted under any, or even under favourable circumstances, is a question which now presents a different bearing from that which it had when Dr. Colles performed it. Brasdor's operation at that time had almost fallen into oblivion. But now, that we know that aneurisms of the first magnitude may be cured, not only by cutting off the circulation within them, but also by causing it to become more slow and languid, Brasdor's method presents itself as an alternative in such cases, which, all things considered, may deserve the preference. Dupuytren treated a case in this manner; and although the issue was not successful, as the patient died on the ninth day, still the tumour had diminished considerably, and his death seemed to arise in consequence of

hæmorrhage from another vessel than that on which the ligature had been placed.

The most cogent reason for operating at an early stage in cases of axillary aneurism, is this—that tying the subclavian is comparatively an easy task, before the tumour has become large, and forced the clavicle upwards; and the higher we ascend on the vessel, the greater the hazard. The inter-scalenar portion of the vessel should always be spared, if there still be space left for the ligature between the scalenus and the clavicle; and if the case will admit of a ligature being placed below the clavicle, it is still better. This precept is not founded exclusively on saving the collateral circulation to the utmost extent possible, for in the cases of this operation that have proved fatal, gangrene has been but rarely observed; it is also based on the fact, of the greater frequency of dyspnoea, suffocation, pain at the heart, fever, and delirium, in proportion as the ligature of this vessel has approached nearer to the centre of the circulation. In fact, where the ligature had been placed high on the vessel, it has been remarked with what rapidity the anastomosing branches have conveyed the blood into its old channels: in some, the pulsations have re-appeared in the tumour as early as the second day after the operation.

Ramsden was the first who performed this operation. In the early cases the failures succeeded each other without interruption, until Dr. Post, of New-York, was fortunate in the case that he operated on in 1807. Since that period, the operation of taking up the vessel between the anterior scalenus and clavicle has been successful in the hands of Dupuytren, Bullen, Green, Gibbs of St. Petersburg, Key, Langenbeck, Liston, Mott, Porter, Wardrop, &c.: the successful now exceeding the unsuccessful cases by a few. With respect, therefore, to results, they are not more encouraging from being placed on the cardiac, than on the capillary side of the aneurism.

INNOMINATA, OR BRACHIO-CEPHALIC ARTERY.

The innominata arises from the arch of the aorta itself, on its right side, and after ascending about two inches towards the articulation of the sternum and clavicle of the same side, gives origin to the right carotid and subclavian. It lies deep, having in front the left subclavian vein, the pneumo-gastric nerve, and some of the branches of the great sympathetic, and behind to the left, the trachea: it is in contact with the pleura to the outside. Though more profoundly situated, it is more accessible than the commencement of the subclavian artery, and can be more easily isolated than that vessel from the investing parts: it is also free from branches.

The innominata was first tied by Mott. He performed the operation as follows:—The patient having been placed on his back, the head thrown considerably backwards, in order to

cause the vessel to ascend as much as possible out of the chest, and the face being turned a little towards the left shoulder, an incision three inches in length was made in a horizontal direction, extending from the median line of the neck outwards, and above the clavicle; a second incision of the same length was then made in a line with the internal edge of the mastoid muscle, until both met. The sternal, and part of the clavicular attachments of this muscle were then divided, and the flap turned upwards; the sterno-hyoid and thyroid muscles were then cautiously divided. The artery was then isolated and tied. Græfe adopted the same method in the case on which he operated; and Mr. Porter, of Dublin, operated in a similar manner, in taking up the lower part of the carotid.

Fig. 83.

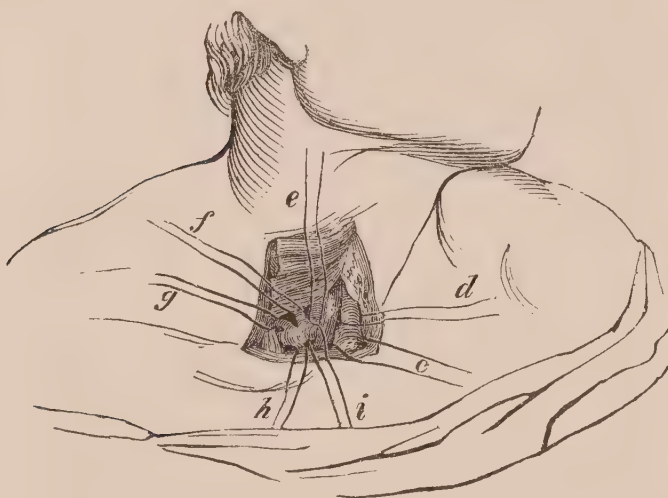


Fig. 83. Mott's plan of tying the arteria innominata.

By a vertical and transverse incision, the inner portion of the sterno-mastoid muscle is detached from the clavicle and raised as a flap. At the inner border of the wound, the arteria innominata (*a*) presents itself, with the internal jugular vein (*b*) descending to its outside, and covering the origin of the subclavian artery. To the outside of the vein is seen the subclavian artery (*c*), giving off (*e*) the vertebral artery, which is here drawn forward from behind the vessel; *f*, the inferior thyroid; *g*, the transverse cervical; and *h*, the internal mammary. A ligature is placed on each of the arteries: *i*, *c*, and *d*, marking those of the subclavian, innominata and carotid. By this plan it will be seen, that the subclavian artery, from its origin to the scalenus muscle, is equally exposed with the innominata itself. The tendon of the scalenus is seen in the outer angle of the wound.

A more simple method than the preceding has been devised by Dr. O'Donnell, of Liverpool, and is thus described by Mr. King in his Thesis: "Standing to the left of the patient, close to his head, which is thrown backwards, I make an incision about an inch and a half in length, along the internal border of the left sterno-cleido-mastoid muscle, beginning at the sternum and dividing the skin, cellular tissue, some of the fibres of the platysma myoides, and the middle portion of the cervical fascia. I then separate the borders of the incision, and divide the cellular line which runs between the internal margins of the sterno-thyroid muscles, and introducing my left fore-finger under the right sterno-thyroid, divide

with my nail or a probe-pointed bistoury, the strong sheet of the cervical fascia that exists between the muscle and the trachea. The finger passed under this fascia descends on the trachea till it touches the arteria innominata, and carefully recognising the position of the artery and causing the head to be bent forwards, I employ the same finger in carrying forwards the left subclavian, and right internal jugular veins. These veins being thus protected, I pass the aneurism needle, armed with a round ligature, between my finger and the artery. The ligature being now placed round the vessel, is tightened slowly and with due precaution. The operation is by no means difficult, on the dead subject at least; nor does it expose to injury, either the pleura, or the pneumo-gastric nerve. It is, moreover, equally applicable to the subclavian and right carotid arteries, with but very slight modification."

If this mode should be resorted to in placing a ligature on the right subclavian, between the scalenus posticus and the trachea, the finger must be directed more obliquely outwards, care being taken to avoid the pneumo-gastric and phrenic nerves. The best way of doing this will be to press the former inwards, and the latter outwards. The noose, formed round the artery by the recurrent nerve, may be easily felt, and of course must be avoided also. The pleura, if it should impede the operator, may be detached gently downwards.

The same mode is also applicable to the left subclavian; but in this case, the surgeon stands to the right of the patient, and instead of cutting in the line of the muscle on the left, he makes his incision along the internal border of the right sterno-mastoid, raising the left sterno-thyroid, and sterno-hyoid muscles. The left fore-finger then descends along the left of the trachea, on the left carotid, and left side of the spine. The pneumo-gastric and phrenic nerves are set aside as before, and the pleura is detached with extreme precaution. The step is difficult on the dead subject, and must be much more so, and perhaps impossible, as Mr. King observes, in the living patient. The isolation of the artery requires much time and care, and in placing the ligature, it should be as distant as circumstances will allow, from the thoracic duct, and great sympathetic nerve. The branches given off from this portion of the vessel on the right side are numerous, but this is not the case with the left subclavian, a circumstance which would weigh much in favour of the chances of a successful result.

The doctrine here propounded by Mr. King had probably excited either curiosity or doubt in the minds of his examiners, more especially as regarded the ligature of the innominata, and he was accordingly requested to demonstrate what he had advanced. A dead body was produced, and in the midst of the hall of the faculty, Mr. King at once satisfied his examiners and a numerous audience, that his plan was not only practicable, but that it might be promptly executed.

Fig. 84.

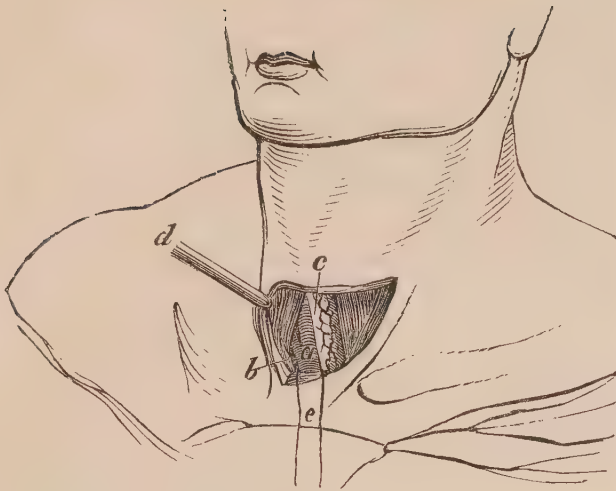


Fig. 84. Mr. King's plan of tying the *arteria innominata*, or the first division of the subclavian artery between its origin and the *scalenus*. The muscles seen at either side of the wound, are the *sterno-mastoid*, *sterno-hyoid*, and *sterno-thyroid*. In the middle the trachea (*c*) presents itself with the inferior thyroid veins ramifying upon it; to its outside is seen the *innominata* bifurcating. The vein (*b*) is also seen in the inferior angle of the wound; between it and the trachea, a ligature (*e*) is passed round the artery (*a*); *d*, the retractor.

But though this operation may be effected without much difficulty in the dead body, it must be very different in the living. The veins from the laborious breathing must at every expiration be swelled with a fresh wave of blood, and consequently are exposed to injury even from blunt instruments; and besides the difficulties and dangers of every kind must be greatly augmented from the proximity of the tumour itself, and the changes which its progress must have induced in the condition and relation of all the parts interested in the operation. But it is unnecessary to dwell further on its perils or difficulties, as in all probability the principle so ably developed by Mr. Wardrop, and the resource he has created for such unhappy cases, will be preferred in future. If, however, any surgeon were disposed to weigh the relative value of the two methods in regard to a given case, he should bear in mind, that the tumour which appears above the sternum may be only a portion, and that perhaps the smallest, of the disease.

The circulation is maintained in the parts from which the main channel is thus cut off in a very circuitous way. The vessels of the opposite side convey the due supply by the anastomosing branches, so that the blood reaches the subclavian and carotid through the branches by which they communicated with the same vessels. The two cases in which the brachio-cephalic trunk has been tied, prove sufficiently that these sources are equal to the supply of the parts beyond the ligature, as in neither was any symptom of gangrene observed. Dr. Mott's patient was operated on in 1818, and was convalescent till the 23d day; a small point of ulceration at the back of the vessel then gave issue to the blood for the first time, and he died exhausted

from successive returns of the hæmorrhage on the 26th day. M. Græfe's patient lived till the 58th day, dying also from a violent hæmorrhage, which he presumed might have been in some degree attributable to his having left, for greater security, a *presse-nœud* in the wound.

Though the brachio-cephalic trunk has been obliterated spontaneously in several instances, it by no means follows that the same result would be obtained by placing a ligature upon it. The spontaneous obliteration is a slow process, whereas the obliteration by ligature is the operation of a few days or weeks; the ligature cuts through the artery, while the adhesions between the sides of the vessel are still fresh and soft, and under these circumstances their solidity can scarce be relied on, in a situation where they are exposed to the powerful impulses of the centre of the circulation. The two instances of the failure of the operation from hæmorrhage alluded to above, confirm this view of the subject.

CAROTID ARTERIES.

The primitive or common carotids arise on the right from the *innominata*, on the left from the arch of the aorta; the latter is consequently longer than the former. At the lower part they lie deep, covered by the *platysma-myoides*, the *sterno-mastoid*, *hyoid*, and *thyroid* muscles, and run upwards before the transverse processes of the cervical vertebræ, between the larynx and trachea, on the inside, and the internal jugular vein which lies outside, and somewhat in front. Between, and behind the vein and artery, is the *pneumo-gastric* nerve included in the same strong sheath with them. On the left side the artery lies also close by the *œsophagus*, which comes out a little on that side from behind the trachea. The course of the carotids upwards towards the angle of the lower jaw appears to be directed in a slight degree obliquely backwards, in consequence of the projection of the *os hyoides* and larynx. It disengages itself from the muscles as it ascends, and becomes, in the middle of the neck, so superficial that its pulsations can be distinctly seen, being covered only by the skin, *platysma myoides*, and fascia. The *omo-hyoid* muscle here crosses it to reach the *os hyoides*, and divides the side of the neck into two triangular spaces. The artery may be tied in either of these spaces.

Ligature of the Carotid Artery.—The patient is placed on his back, the chest elevated, the neck stretched, and the face turned to the opposite side. The pulsations of the artery having been felt, an incision, three inches in length, is made along the internal border of the mastoid muscle, extending from the level of the cricoid cartilage, nearly down to the sternum. The subcutaneous cellular tissue, the *platysma myoides*, and the cellular tissue that connects the *sterno-mastoid*, *hyoid*, and *thyroid*, muscles are next divided in succes-

sion. If any external veins should lie in the direction of the incision, they must be set aside. The situation of the incision itself will only vary according to the part of the vessel to be tied, and may be higher or lower in its course. The head being now bent, the lips of the wound are opened wide. If the omohyoid muscle be in the way, it may be set aside; or should this be not practicable, it may be divided on a director. The vein and artery are now seen enveloped in a very strong fibrous sheath. They are at once distinguished from each other by their relative positions, as well as by their difference of colour, the one being a dark blue, the other a whitish yellow. As the vein, on account of the thinness of its coats, should be an object of especial care, the perforation of this tough sheath should be effected with a blunt instrument over the artery. This being done, the director is introduced, and the sheath laid open. If the internal jugular, from its being swollen with blood, should mask the artery, it should be compressed by the finger at the upper part of the wound, its fulness will be thus made to disappear. They are then separated, and the pneumo-gastric nerve is carried on the same side as the vein; the needle is then passed from without, inwards, beneath the artery, and in doing this, care must be taken not to include the descendens noni which lies on its tracheal side. (For the details of this operation, see No. 2, Fig. 81.)

If the jugular vein were unfortunately wounded, the surgeon might pursue the same course as the late Mr. Simmons of Manchester, who placed a ligature upon it; or as Mr. Guthrie, who, in the case of another vein, pinched up the lips of the wound on its side, and tied them, thus leaving a portion of it still permeable; or he may plug the whole solution of continuity.

M. Sedillot has proposed another method of cutting on the artery at its lower part, by making an incision between the sternal and clavicular portions of the sterno-mastoid muscle. This incision exposes the vein and artery; the latter is then isolated in the manner already described. This proceeding has not been as yet executed on the living body.

In a case of carotid aneurism, in which the sac had burst into the œsophagus, and where the tumour was situated very low down, Dr. Robertson of Edinburgh operated by guiding the incision along the internal border of the sterno-mastoid muscle. No greater difficulty was encountered in the operation than might have been fairly expected to arise from the too limited extent of the external incision, which was but little more than an inch. The sterno-thyroid, and part of the sterno-hyoid muscles were divided transversely. A small prolongation of the sac was then seen between the carotid and the trachea. There was only space enough between the sac and the innominate to insert the end of the finger, so that the ligature was upon the carotid, within half an inch of its origin from the brachio-cephalic

trunk. The tumour had effected such a displacement of the neighbouring parts, that neither the veins, nor nerves were seen. The wound healed by granulation, the ligature being detached on the seventeenth day¹.

From the superficial situation of the carotids it might be supposed that the diagnosis of aneurism in this vessel might be a matter of little difficulty. Some mistakes have, however, occurred, which have been attended with fatal consequences. Scarpa mentions an instance in which a carotid aneurism was opened for an abscess; and in another case mentioned by Harder, a patient died under the surgeon's hands. The surgeon should, therefore, take all proper pains on this point, and pay strict attention to the rules by which two such different affections are to be discriminated.

Long before the idea of placing a ligature on the carotid had been entertained, several cases had been observed in which the vessel was spontaneously obliterated; and one instance is recorded in which both carotids were obliterated. The first instance in which it appears to have been tied, occurs in Hebenstreit's Translation of B. Bell's Surgery: in extirpating a scirrhus tumour, the carotid was wounded: the surgeon, to save the patient's life, immediately tied the vessel, and she lived many years afterwards. Abernethy was the next to perform this operation successfully; and was followed by Fleming, a naval surgeon, who tied the wounded carotid in a sailor who attempted to commit suicide. Since that period the ligature of the carotids has become a common operation, and has been had recourse to in a very great variety of cases. In the extirpation of the lower jaw, or of large tumours in its vicinity, it has sometimes been employed as a preliminary proceeding. It has also been found successful in curing erectile tumours, or aneurisms by anastomosis, developed on various parts of the head and face. Mr. Travers tied the carotid in a case of this kind, in which, from the progress of the tumour, the eye was extruded from its socket; the disease was perfectly cured. Mr. Dalrymple treated a similar case in the same manner, and the termination was equally satisfactory. Arendt treated another case in this manner, and Mr. Wardrop pursued the same course in a case of aneurism by anastomosis of the eyeball in an infant. It has also been employed successfully in arresting hæmorrhage arising from ulcerations of the pharynx and larynx. The operation of tying the primitive carotid is applicable to aneurismal tumours developed superiorly to the point of ligation, and to those which occur in its subdivisions, the facial, temporal, and occipital, when compression is found unavailing; while the absence of branches throughout a great part of its course, renders it peculiarly eligible for the application of Brasdor's method in cases of aneurism of the innominate.

¹ Dublin Journal of Medical Science, &c., January, 1838.

Wounds of the carotid are not necessarily fatal. Some instances are on record in which the blood having but a small external vent became diffused, thus giving rise to a traumatic aneurism. Cases, too, have occurred in which wounds of the carotid have been successfully treated by compression alone. Acrel, Van-Horne, and Larrey, make mention of three such instances.

The sources of supply are so abundant, after the ligature of the carotid, that there is not the slightest danger to the parts either within or without the cranium, from which the main stream has been diverted; and no one now entertains the slightest fear for the intellectual or other functions of the brain. Indeed, the branches of the opposite and corresponding vessels anastomosing with those of the obliterated trunk, replenish them so very rapidly, that in some instances the pulsations have reappeared in the tumour, after a brief suspension, and thus rendering it necessary to have recourse to compression to make the cure certain. This phenomenon so often observed furnishes indisputable proof of the correctness of Mr. Wardrop's position, that a languid state of the circulation is sufficient to lead to the gradual obliteration of an aneurismal sac.

Irregularities in the distribution of the carotid artery usually arise from some variation of the point at which it bifurcates; the division into the two secondary branches may take place as low down as the sixth cervical vertebra, or as high up as the styloid process; or again, there may be no bifurcation, in which case the primary carotid, after giving off all the branches usually furnished by the external, is continued as the internal carotid.¹

The irregularities of the secondary branches follow in the same order; but some occur independently of any anomaly of the primary trunk. Thus the superior thyroid may arise from the external carotid, a little above the bifurcation, or it may arise either from the external, or from the common carotid by a common trunk with the lingual artery. Sometimes it is wanting altogether. The lingual and the facial may also arise by a common trunk from the carotid. The latter is peculiarly liable to variation, insomuch that it is seldom distributed in the same manner at each side, in the same person.

INFERIOR THYROID, SUPERIOR THYROID, FACIAL, AND LINGUAL ARTERIES.

The inferior and superior thyroids, the former a branch of the subclavian, the latter a branch of the common carotid, have been tied in cases of degenerescence or hypertrophy of the thyroid gland.

Ligature of the Inferior Thyroid and Vertebral Arteries.—The inferior thyroid arising from the subclavian, or from a root common to it, and the ascending cervical, runs up-

wards and inwards behind the internal jugular vein and carotid, and the pneumogastric nerve, and just before the vertebral artery, and longus colli muscle, until it gets behind the lobe of the thyroid body; it is crossed and covered by the omo-hyoid muscle. It may be cut down upon in the same manner as the carotid, and sought for under this muscle between the carotid and the trachea, or the œsophagus and trachea, if it be on the left side. Care must be taken not to injure the descendens noni, or the recurrent nerve. Sedillot's plan of tying the carotid by cutting down between the sternal and clavicular portions of the mastoid muscle might also be adopted either for tying the inferior thyroid, or even the vertebral artery itself.

Fig. 85.



Fig. 85 contains the temporal, facial, lingual, and subclavian arteries.

No. 1. The skin and temporal fascia having been divided, the temporal artery (a) is seen with its satellite vein; b b, the ligature passed under the artery.

No. 2. The skin and fascia covering the edge of the lower jaw are divided; the facial artery (a) with its satellite vein is seen ascending towards the angle of the mouth; a ligature (b b) is passed under the artery.

No. 3. The skin and platysma myoides are divided by a transverse incision. Beneath the hypoglossus muscle, which is also divided, are seen, a, the lingual artery, b, the vein, and d, the hypoglossal nerve; c, is a portion of the sublingual gland presenting itself in the upper edge of the wound; e e, the ligature passed under the artery.

No. 4. a, the subclavian artery; b, the vein to its inside; c c c, the nerves descending to form the brachial plexus; d d, the ligature passed beneath the artery; the nerves and artery are crossed by venous branches (e) which are descending to empty themselves into the subclavian vein. The subclavian vein and artery are separated by the scalenus muscle.

¹ Dr. Green, on the Varieties in the Arterial System.

Ligature of the superior thyroid:—This branch arises from the carotid, at or near its bifurcation; it takes a curved direction downwards, and inwards till it reaches the upper part of the thyroid gland.

The operation is the same as in cutting down upon the carotid itself, in the superior triangular space. It will be found accompanied by one or two small veins, between the carotid, and the lobe of the thyroid body, where it may be easily isolated.

Ligature of the facial or external maxillary and lingual arteries:—This branch of the carotid arises higher up than the superior thyroid, from which it is separated by another important branch, the lingual. An incision the same as for the carotid itself, should be made so that its middle would be just on a level with the cornua of the thyroid cartilage. As soon as the sheath of the carotid is laid open, the facial artery will be seen ascending obliquely upwards and inwards towards the lower jaw. The lingual artery will also be easily discovered running a little deeper, first in a horizontal and then in an oblique or vertical direction, between the os hyoides, and muscles of the tongue.

Another method has been proposed for tying the lingual artery. On reaching the upper part of the great cornua of the os hyoides, it lies close behind it, but it then ascends, advancing between the middle constrictor of the pharynx, and the hyo-glossus muscle, until it gets to the distance of nearly an inch from the body of the bone in front. The operation is performed in the following manner. The patient being placed on his back, the neck stretched and the face turned away, an incision of an inch or better in length, is made in the direction of the artery, above and parallel with the os hyoides. The skin and platysma myoides being divided, the facial vein is drawn backwards with a blunt hook. In the upper part of the wound the submaxillary gland is seen, its sheath having been opened; the digastric and stylo-hyoid muscles are also exposed; these being also held aside, the hyo-glossus muscle is discovered, beneath which the artery lies. This muscle must be divided with care, raising the fibres with a dissecting forceps, or dividing them on a director. It is easily isolated: the hyo-glossal nerve runs above it. (No. 3, fig. 85.)

This artery is mostly wounded in attempts at suicide; in those cases it may be tied on the surface of the wound. It gives origin to the ranine arteries, which lie at each side of the frænum. (See ANKYLOGLOSSUM.)

ARTERIES OF THE HEAD AND FACE.

Ligature of the facial artery on the lower jaw:—The artery in this situation, lies in front of the edge of the masseter muscle, and being quite superficial, it can be easily felt pulsating upon the edge of the bone. The direction of the incision may be either horizontal or obliquely vertical. Beneath the

fascia, the artery with its accompanying vein is immediately seen. (No. 2, fig. 85.)

Ligature of the temporal artery:—This vessel is easily found about three lines in front of the ear, and just above and behind the zygomatic arch. An incision, about an inch in length, will bring it into view; it is seen enveloped in a strong cellular sheath furnished to it by the temporal muscle. It can be isolated without difficulty. (No. 1, fig. 85.)

Ligature of the occipital artery.—Derived from the external carotid, this vessel passes below the upper portion of the digastric muscle, under the upper part of the mastoid muscle, and crosses the upper and back part of the neck. Its course is horizontal for about an inch, just below the ear and mastoid process. An incision drawn in this direction, and in a line with the edge of the lower jaw, will fall upon the artery; it is accompanied by a vein, and gives off several branches which intertwine with those of the vein. It is easily isolated. (No. 1, fig. 81.)

From the exposed situation of the arteries of the head and face, their aneurisms are chiefly of the traumatic kind. Spontaneous aneurisms have also been observed both without and within the cranium. Bégin relates a case in which an aneurism was formed in the middle meningeal artery. The bone having been absorbed, the tumour became superficial. It was mistaken for an encysted tumour, and extirpated. An ineffectual attempt was made to arrest the hæmorrhage by plugging; the patient however could not be saved. Mr. Hodgson mentions a case in which he found a small aneurismal sac in the anterior cerebral artery, which was filled with a solid coagulum; and another of the basilar artery has been observed by M. Serres. Sir A. Cooper found a small aneurismal sac on the central artery of the retina.

All the external branches have been also observed in divers instances to be the seat of spontaneous aneurisms, the aneurismal tumours presenting themselves in various points of the temporal, occipital, labial, and facial arteries; and M. Godichon has seen a case of aneurism of the frontal branch, in which the sac was as large as the thumb. Dr. P. H. Green has recently met with a case of spontaneous aneurism of the temporal artery.

If the aneurismal tumours that are developed within the cranium could be diagnosed with certainty, as indeed they may be when the bone covering them has been removed by absorption, the proper remedy would be the ligature of the carotid artery of the same side. This proceeding is also generally preferred in the cases of external aneurisms that have proved rebellious to compression, excepting in the aneurisms of the facial and temporal arteries.

The cylindroid dilatation of these external vessels has been also observed. While recently on a visit to Glasgow, my friend, Dr. John M'Farlane of that city, showed me a case of this kind in a gentleman about twenty

years of age, who had come from Cambelton to consult him. The dilatation occupied the superficial, temporal, and frontal branches: the vessels were very voluminous, soft, and extremely tortuous; and the wave of blood upheaving the mass could be very distinctly felt. The progress of the dilatation had been slow.

INFERIOR EXTREMITY.

Aneurisms of the inferior, are comparatively more frequent than those of the superior extremity; in the foot, however, as in the hand, they are of rare occurrence. It has been even doubted by some surgeons, if any case of aneurism of the dorsal artery of the foot has been ever observed. But though exceedingly rare, this form of the affection has nevertheless occurred. Guattani mentions a case that had been caused by the operation of blood-letting in the foot, and three other cases are recorded by MM. Roux and Vidal. From the position of the artery, and its resting on the astragalus, navicular, and cuneiform bones in its course, from beneath the annular ligament of the tarsus, at the upper part of the instep, to the point where it bifurcates, and dips down between the first and second metatarsal bones, compression will be particularly applicable. If, however, it should be found necessary to resort to ligature, it should be placed double, both above and below the tumour. Indeed this precaution becomes the more necessary as the aneurism happens to be more remote from the centre, in consequence of the more frequent communications that are established between the branches of an arterial trunk. This observation applies equally to aneurisms in the hand or on the head, and more especially, when the lesion of the artery is of the traumatic kind. The application of a single ligature above the aperture of the vessel, might, in such cases, be insufficient, as the blood would continue to reach the tumour, through the anastomosing branches.

Ligature of the dorsal artery of the foot:—In its course, it runs between the tendon of the common extensor, and the proper extensor of the great toe.

Fig. 86.

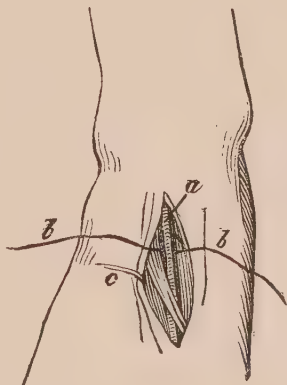


Fig. 86. *a*, the dorsal artery of the foot between its two satellite veins; *b b*, the ligature passed under the artery; *c*, a retractor, holding back the external lip of the wound.

The patient being placed on his back, the foot extended and slightly bent, is held by an assistant. An incision of an inch and a half or two inches is made from the tarsal annular

ligament, along the outside of the proper extensor of the great toe. The division of the skin and cellular tissue exposes a thin aponeurosis which covers the artery itself. The vessel being isolated from its accompanying nerve and veins, a ligature is passed beneath it, and tied; if a second be necessary, it is applied in the same manner.

ARTERIES OF THE LEG.

Spontaneous aneurisms are extremely rare in the leg; those which require the intervention of the surgeon in this region, being chiefly of the traumatic kind. The arteries are derived from the popliteal, and are distributed on the front and back of the leg. The anterior tibial artery passes through an opening at the upper part of the interosseous ligament, and thus commences its course deep between the tibia and fibula, and lying on the interosseous ligament. It is covered by the mass of muscles, the tibialis anticus, extensor digitorum, and extensor pollicis; in the upper part of the leg, it descends first between the tibialis and extensor communis, next between the tibialis and extensor pollicis; on reaching the ankle, it passes beneath the annular ligament; deep-seated above, it gradually becomes more superficial throughout the rest of its course, resting in the lower part on the outside of the tibia. Its whole track corresponds with a line drawn from the middle of the space between the head of the fibula, and spine of the tibia, to a central point between the two malleoles. Its great depth above, and the proximity of the articulation below, are reasons for not tying it in either of these situations; the intermediate space being always preferred for this purpose.

Ligature of the posterior tibial artery:—This vessel is larger than the anterior branch, and may therefore, in consequence of its size and direction, be regarded as the continuation of the popliteal artery. It descends from the lower edge of the popliteus muscle, between the superficial and deep-seated muscles on the back of the leg. Its course would be represented by a line drawn from the centre of the hollow of the ham, to between the internal malleole and the tendo achillis; curving a little however towards the inside of the leg. Above it rests upon the posterior tibial muscle, and is deeply covered with the gastrocnemius and soleus; but the muscles becoming tendinous below, depart from the artery, so that it is superficial where it runs along the edge of the tendo achillis, being only covered by the skin and aponeurosis; it then descends behind the internal malleole, from which it is separated only by the tendons of the posterior tibial and common flexor muscles, enveloped in their sheath. Throughout this course, it is accompanied by two veins, one at each side, and the posterior tibial nerve, which lies to its fibular side. The artery may be cut down upon, at several points of this course.

Behind the internal malleole:—The leg being bent, and resting on its outside, and compression being made on the femoral artery in the thigh, or against the pubis, a vertical incision is made, about two inches long, midway between the malleole and the tendo achillis. This incision, which divides the skin and subjacent cellular tissue, runs for the first inch parallel to the tendo achillis, and then curves gently towards the sole of the foot. The aponeurosis, which is extremely strong, is now seen stretched between that tendon and the edge of the tibia; this being divided cautiously with the point of a bistoury, or on a director, the next step is to pass the needle under the artery and secure it.

Fig. 87.

Fig. 87. *The posterior tibial artery (a), with its satellite veins, occupies the centre of the wound. b b, the ligature passed under the artery; c c c c, the section of the strong fascia which covers the vessels, and binds down the flexor tendons that pass behind the malleole.*



At the middle third of the leg, or between the ankle and the lower part of the calf:—In this situation the artery runs parallel to the tibia, and within half an inch of its internal border; it lies in its own sheath, on the common flexor of the toes, and the long flexor of the great toe, covered by the fascia, adipose tissue, and integument. The incision in this operation must be between two or three inches long, running parallel with the internal border of the tibia. The aponeurosis covering the vessels being exposed, it should be divided with the usual precaution on a director. The artery and its two veins are then seen in the relation already described, the nerve also lying to its outside. When the incision is made closer to the tibia, there will be but one plan of fascia to divide, but there will be also the risk of not coming with so much certainty on the vessel. If the soleus should descend more than usual, it can be easily raised, as soon as the incision is made. The ligature is passed as before. (No. 2, fig. 88.)

Lisfranc recommends the incision to be made in an oblique direction, beginning at the inner border of the tendo achillis, and ascending, under an angle of 35 degrees to the inner border of the tibia. As soon as the integument and aponeurosis are divided, the soleus is detached from below, upwards, with the index finger, and the artery is thus exposed.

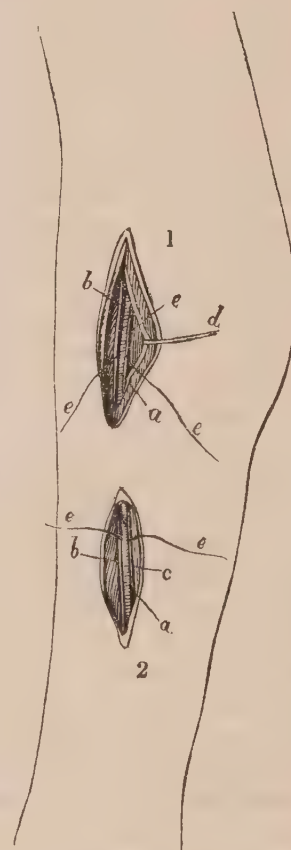
At the upper third of the leg:—In consequence of the depth at which the artery is situated, and the thickness of the soft parts, the incision should be at least from three to four inches in length, commencing about an inch behind the internal edge of the tibia,

and descending parallel to that bone. The internal edge of the gastrocnemius is detached from the soleus, and raised in the posterior lip of the wound; the fibres of the soleus itself are then divided longitudinally and to the same extent as the integuments. The interstice that exists between the soleus and tibialis posticus, and in which the artery runs, is recognized by the shining pearly appearance of the aponeurosis that envelopes the vessels. The course of the artery being oblique from above downwards, the higher it is taken in its course, the nearer will it be found to the middle of the leg. The muscular mass being retracted by means of a blunt hook, the aponeurosis is divided on a director, and the artery being isolated from the accompanying veins and nerve, the ligature is placed on the vessel. (No. 1, fig. 88.)

Fig. 88.

Fig. 88. No. 1. *The muscles of the calf are retracted, the white line seen on their border is a section of the strong fascia covering the soleus; on the opposite side of the wound is seen the section of the fibres of the soleus itself. a, the posterior tibial artery, its satellite veins (c) running at each side of it; d, blunt hook; e e, the ligature passed under the artery.*

No. 2, *a, the posterior tibial artery between its two veins, b; c, the nerve; e e, the ligature passed under the artery.*



This operation is exceedingly difficult, both on account of the great depth of the artery, and the contraction of the large and powerful muscles of the calf of the leg. In one case, to obviate this excessive contraction, Bouchet of Lyons was obliged to divide part of their fibres, and Mr. Guthrie, in another case preferred cutting down on the vessel at once, directly through the thick of this muscular mass itself. If the saphena vein should lie in the line of the first incision, care should be taken not to wound it.

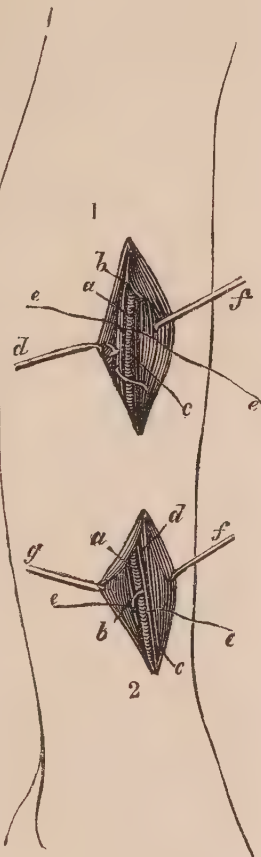
Sometimes the posterior tibial is altogether wanting, its place being taken by branches from the fibular, which is unusually large.—(Green.)

Ligature of the anterior tibial artery:—In cutting down upon this artery, the external border of the tibialis anticus will serve as a guide for the incision. In some subjects, this

interstice can be rendered discernible to the touch, and even to the sight, by moving the foot so as to render the tendon of the tibialis prominent; in others, however, it is faint, and will require some pains to distinguish it.

Fig. 89.

Fig. 89. No. 1. *Ligature of the anterior tibial artery at the superior-third of the leg. The skin and strong fascia being divided, the tibialis anticus is held against the outer side of the tibia by the retractor (f), the extensors of the toes are held back by the blunt hook, d. a, the tibial artery; b, the nerve; c, the satellite veins at each side of the artery; e e, the ligature passed beneath it.*



No. 2. *Ligature of the anterior tibial artery at the inferior-third of the leg. The same parts having been divided, the tendon of the tibialis anticus is held towards the tibia, and those of the extensors backwards by two hooks (g and f); the anterior tibial nerve (c), lies now to the tibial side of the artery (a); b, the satellite veins entwining upon it in front; e e, the ligature passed under the vessel.*

The patient is placed on his back, the leg and foot extended. As in all cases, where it is necessary to separate muscles, the surgeon should have the power of extending or relaxing them at pleasure. A vertical incision is made, extending three inches, or more if the patient be strongly built; the skin and cellular tissue are thus divided; the two muscles, the tibialis and extensor communis, if above, the tibialis and extensor pollicis if below, are then separated with the finger, or a blunt knife; or if any difficulty should be anticipated of falling on the muscular interstice, the incision may be made with a slight obliquity of direction. The artery with its accompanying veins is thus brought into view; the tibial nerve lying to the outside. When the vessel is cut down upon at the lower part of the leg, the nerve will be found at the inside, as it crosses the artery obliquely in its course from above downwards. If the depth be considerable, the isolation of the vessel will be facilitated by relaxing the muscles, and this facility will be still further increased by dividing transversely the strong aponeurosis which binds them down. The muscles should be relaxed as much as possible and held well asunder, otherwise the carrying the ligature under the artery will be found a matter of no small difficulty. In the lower part of the leg, the vessel lying in the midst of tendons, is much more accessible, and may be found by making an incision two inches in length,

along the external edge of the tendon of the tibialis: the artery is soon discovered by separating the tendons which conceal it.

Peroneal artery:—The French surgeons describe the mode of cutting down on this artery. Its course from its origin from the outer side of the posterior tibial artery, at about an inch below the separation of the vessel from the popliteal is downwards towards the lower part of the fibula. Though at first of considerable size, it soon becomes so small as to fall beneath the size that would require the application of a ligature. If an aneurism were developed in the upper portion of this artery, most surgeons in this country would prefer placing a ligature at once, either on the popliteal or the femoral.

Fig. 90.

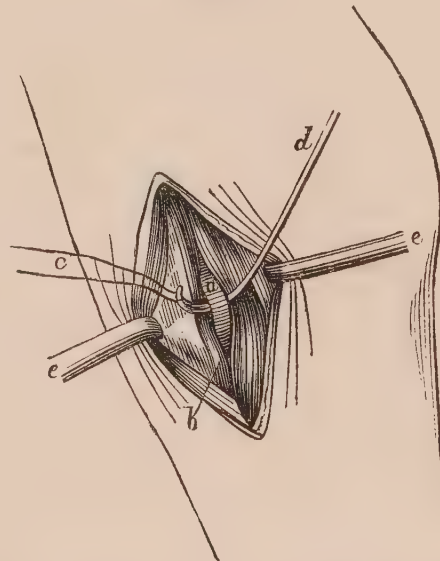


Fig. 90. *The muscles of the calf are retracted inwards, the flexor longus outwards; the vein and artery lie close together, the former to the outside. a, the peroneal artery raised on an aneurism needle (d); c, the ligature; b, the vein; e e, the retractors.*

The mode in which the ligature may be applied on the peroneal itself is described as follows: the artery is to be sought for about the middle of the leg, or a little lower, at the point where the soleus parts from the gastrocnemii. The incision should be two inches long, extending from the back of the fibula, to the external edge of the tendo achillis. The skin and aponeurosis being divided, the artery will be found on the inside of the flexor longus pollicis pedis. Mr. Guthrie, however, in a case of traumatic aneurism of the peroneal artery, preferred the method already mentioned, of cutting through the thickness of the calf of the leg, to placing his ligature on the femoral artery. The vessel may, it is true, be reached by either of these methods; but by that here described, the extent of incision will not be half so great.

For aneurisms of these several vessels, particularly if occurring near their origin, the popliteal artery itself may be cut down upon and tied.

This artery varies much in size, being influenced, in great measure, by the magnitude of the anterior tibial. Sometimes it does not

exist as a distinct vessel, but its place is supplied by branches from the posterior tibial; sometimes its anterior branch is furnished by the anterior tibial, or in rare cases by a perforating branch from the posterior tibial.—(Green.)

POPLITEAL ARTERY.

This name is applied to the trunk of the inferior extremity from the point where the femoral artery passes through the tendinous attachment of the adductor and vastus externus muscles, to the lower edge of the popliteus muscles, where it divides into the arteries of the leg. The whole course of the vessel, which is directly downwards, with a slight inclination outwards, corresponds with the inferior fourth of the femur, and the superior fifth of the tibia. At first, it lies in the middle of the space, which is bounded by the biceps on the outside, and the semi-tendinosus and semi-membranosus on the inside; it then passes over the back of the knee-joint, between the two condyles of the femur, just before the notch that separates them, and then between the two heads of the gastrocnemius externus. The whole of this space is filled up with firm fat, in which the vessels and nerves are somewhat deeply imbedded, and in which are several small lymphatic ganglions. The artery itself lies deepest, the vein close upon it, but a little to its outer side, the nerve is the most superficial. On passing below the joint, the artery rises more towards the surface, and its relations with the vein and nerve become altered as these pass over it to get to its inside, or they divide, the artery occupying a central situation between both. In consequence of this greater proximity to the surface, the vessel is much more easy of access, where it passes between the heads of the gastrocnemius, a circumstance which may be turned to good account in operative surgery, as the ligature placed on the popliteal artery in this situation, will save very important articular branches for carrying on the circulation after its interruption in so considerable a trunk.

Ligature of the popliteal artery at its lower part:—The patient is made to lie on his belly, and the leg is held moderately extended. A longitudinal incision, corresponding with the line that separates the two heads of the gastrocnemii, is made in the median line, beginning just below the joint, and extending between three or four inches down the limb. The skin, cellular tissue, and fascia having been divided, the surgeon now lays aside the knife, and separates with his fingers the heads of the gastrocnemii. The popliteal artery is found, the vein and nerve, holding with it the relations already described. After the incision is made, the leg should be bent slightly on the thigh, in order to facilitate the exposure of the artery; care should also be taken not to wound the external saphena vein, should it lie in the line of the incision. The vein and nerve being drawn to the inside, the

needle is passed beneath the artery from within, outwards.

Fig. 91.

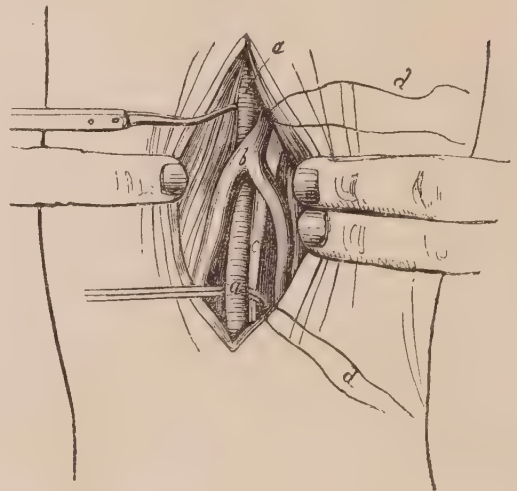


Fig. 91. *The lips of the incision being held apart by assistants, the semi-membranosus and biceps are seen under their fingers, the former to the inside, the latter to the outside. a a, the popliteal artery raised above on an aneurism needle, below on a flexible director, both armed with ligatures, d d; b, the popliteal vein receiving the posterior saphena vein; c, the popliteal nerve.*

By prolonging the separation of the gastrocnemii still further downwards, and dividing the firm aponeurosis of the soleus, the divisions of the popliteal artery also are rendered accessible to the ligature.

In wounds of the lower half of the popliteal artery, a ligature may be placed on any part of the upper half, either by enlarging the wound accidentally inflicted, or by cutting down upon it in the superior part of the hollow of the ham. The incision for this purpose should be very free, and should extend from the upper part of the popliteal space, and near to the muscles that form its internal boundary, in a slightly oblique line, down to its middle at the back of the articulation. The skin and aponeurosis being divided, the fat that fills up the hollow of the ham comes into view. This is torn or separated with the fingers, or a blunt knife. The nerve being the most superficial, presents itself first, the vein next, and then the artery. The isolation of the vessel is somewhat difficult, on account of its depth, and close connexion with the vein. In meagre patients the dissection will be proportionably less difficult.

POPLITEAL SPACE.

The great extent and depth of the popliteal space, affords room for the development of an aneurismal tumour, and hence it is that these tumours often attain a certain size before they become prominent in the ham. The strong aponeurosis also, with which the space is closed and bound down, resists powerfully their rapid growth. Owing to these circumstances, the aneurisms that occur in this region present at first a somewhat flattened appearance, enlarging gradually towards the sides, as the disease makes progress. The

nerves, veins, and lymphatics are thus exposed to a considerable degree of compression, the normal relations of the bones and muscles are altered, the motions of the limb are impeded and painful, and there is infiltration of the leg and foot, with pain and numbness. In some instances this strangulation has proceeded so far as to disorganize the great nerves, and produce mortification of the limb itself; in others, the bones, cartilages, &c. have become eroded; the aponeurosis will, however, not unfrequently give way first, the aneurismal sac being then covered by the integument alone. Sometimes too, inflammation seizes on the whole tumour, and the aneurism is cured by being converted into an abscess.

Aneurisms occur frequently in the hollow of the ham, a circumstance which has been attributed by some surgeons to its vicinity to the knee-joint, where it is exposed to incessant flexion and extension. Flexion and extension however, so long as the coats of the artery are in a healthy state, will not cause an aneurism, and it is only when the tunics of the vessel have undergone some morbid alteration, that these become the occasional cause of its production. It has been observed to occur with comparative frequency in coachmen, jockeys, postillions, and drunkards.

Mr. Hodgson's plan of determining the frequency of aneurism in the different arteries has been followed out on a more extensive scale by Lisfranc. The following table exhibits the relative frequency of each in 179 cases of aneurism, those of the aorta being omitted:

1. Popliteal	59
2. Femoral { at the groin	26
{ at other points	18
3. Carotid	17
4. Subclavian	16
5. Axillary in the arm-pit	14
6. External iliac	5
7. Innominata	4
8. Brachial	3
9. Primitive or common iliac	3
10. Anterior tibial	3
11. Gluteal	2
12. Internal iliac	2
13. Temporal	2
14. Internal carotid	1
15. Ulnar	1
16. Peroneal	1
17. Radial	1
18. Palmar	1

Mr. Hodgson's table contains 63 cases, including, however, 29 of the aorta and innominata. The remaining cases are:

Carotid	2
Subclavian and axillary	5
Inguinal	12
Femoral and popliteal	15

The above tables embrace cases of spontaneous aneurism only.

It is but little more than fifty years since

our best surgeons were afraid to place a ligature on such a large vessel as the popliteal. The idea, that by obliterating the main trunk, the mortification of the limb became inevitable, induced a belief that the aneurisms in this region, which had resisted the treatment by compression and debilitation, could only be treated by amputation; and when a case occurred, where success had followed the application of a ligature, its importance was explained away by attributing the fortunate result to some anomalous distribution of the vessels, furnishing other channels of supply. The capabilities of the collateral circulation were to a great extent unknown. In this region, the anastomosing branches, though small, are numerous, and the articular arteries instead of being insufficient, are much more likely to cause the return of pulsation in the aneurismal tumour, by the great force of the recurrent circulation, which soon becomes established through them.

Compression has been successfully resorted to in a certain number of instances, but they have not, however, been sufficiently numerous to permit the surgeon to be very sanguine of a favourable result, whatever be the mode of compression he may adopt. Neither should he rely on Valsalva's method, to the waste of valuable time. Under favourable circumstances, and where the patient is timid and young, refrigerants, compression, and debilitation may be had recourse to, separately or conjointly, and with advantage; but the surgeon should know when to desist: he should hazard nothing in favour of a remedy which, though more tolerable to the imagination of the patient, is at the same time less efficacious and less certain than that which he looks upon as a dernier ressort.

These aneurisms, however, like all others, are sometimes cured spontaneously; and more than once, patients admitted into hospitals for the purpose of undergoing the operation, have been dismissed cured, without the intervention of any other means than rest and simple bandaging.

Before Hunter's time, when the ligature was had recourse to, the mode employed was to place one, both above and below the tumour, according to Keysler's plan, and emptying it of the coagulum. In this country, a plan so dangerous was soon supplanted by the Hunterian operation. In France, however, it was continued until a comparatively recent period. Boyer was one of the last of its defenders.

Neither Brasdor's nor Mr. Wardrop's methods have been as yet employed in these cases; but it is the opinion of some very good authorities, Velpeau among others, that where the tumour is still small, and has not produced extensive disturbance, and that it is situated so high in the ham as to leave a sufficient portion of the vessel below the articulation to allow room for placing a ligature, that one or other of these methods might be tried with a fair prospect of success.

FEMORAL ARTERY.

Emerging from the pelvis, this vessel passes under Poupart's ligament, and enjoys the name of femoral, until it reaches the opening through which it penetrates the adductor. Its course would be represented by a line drawn from the centre of the crural arch, and passing obliquely downwards, till it gets quite behind the femur, towards the notch that separates its condyles. In this course, it gives off some important branches. The artery may be tied, either above or below the middle of the thigh, or indeed at any point of its course. The aponeurosis, so frequently alluded to, as covering the arteries in other situations, here assumes the form of a sheath, which extending from Poupart's ligament to the opening in the adductor, envelopes both the femoral artery and vein. The sartorius muscle, as it crosses the thigh obliquely from above downwards, lies at first to the outside of these vessels; it then covers their sheath as a riband, and lastly, gets to the inside of them long before it reaches the inner border of the ham. In relation to this muscle, therefore, the great femoral vessels may be said to occupy three different situations, as they are found on the inside, beneath, or on the outside of its course. The saphena vein, which may be seen ascending on the inside of the thigh to dip into the femoral vein at its upper part, lies somewhat backwards as regards the course of the artery.

Fig. 92.

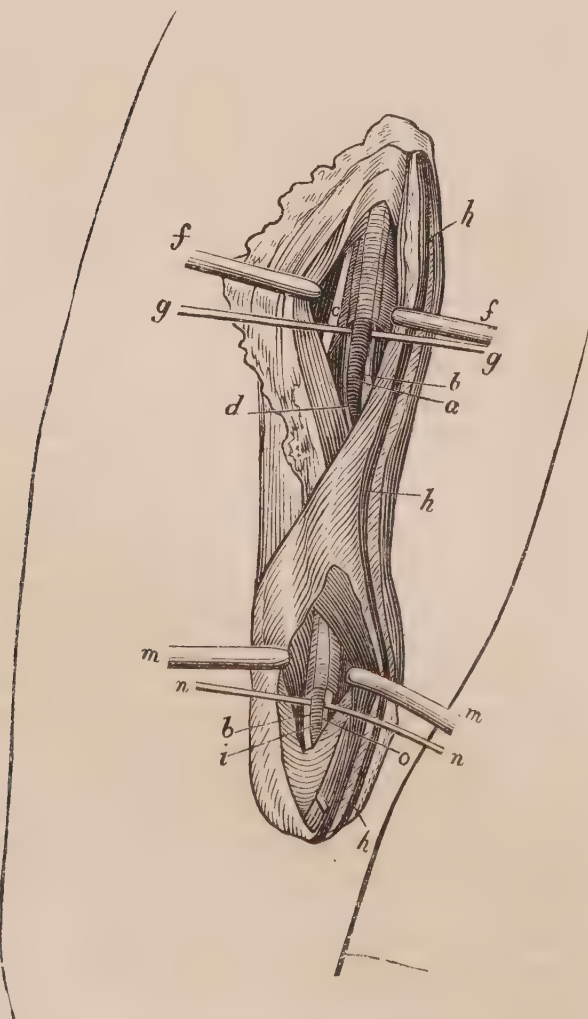


Fig. 92 exposes the femoral artery at two different points; the superior third, and the inferior third of the thigh.

Above, the skin, cellular tissue, and superficial fascia having been divided, the sheath of the femoral vessels, in part laid open and in part still covering the vessels, is seen. Along the inner border of the wound, and parallel with the edge of the skin, the saphena vein is seen ascending, throughout its entire length. On the opposite side the internal edge of the sartorius is retracted. *a*, the femoral artery raised on a director (*g g*); *b*, the femoral vein; *c*, the crural nerve; a satellite nerve (*d*) is also seen running alongside the artery; *f f*, the retractors; *h h h*, the saphena vein.

Below, the same parts are exposed; the division of the sheath of the vessels is prolonged, to show the passage of the femoral vessels backwards into the popliteal space. *m m*, the retractors holding the aponeurotic insertion of the vastus internus to the outside, and the anterior edge of the sartorius to the inside. The artery is raised on the director (*n n*); *i*, the crural nerve; *o*, the vein; *b*, the artery; *h*, the saphena vein.

In the superior division, the femoral vessels are lodged in a triangular space, the base of which is formed above by the border of Poupart's ligament, its internal border by the pectineus and adductor longus muscles, the external by the sartorius. In this space they are only covered by the skin, fascia lata, fat, in which the lymphatic glands lie scattered, and their own sheath, and consequently are more superficial than in any other part of their course. In this space too, the great saphena vein empties itself into the femoral vein, which lies on the internal or pubic side of the artery; the anterior crural nerve is on the opposite side, and a little distant from it.

The artery becoming deeper seated, disappears in the apex of the triangular space above described, beneath the sartorius muscle.

In the third or lowest division, the sartorius lies to the inside of the artery until it passes close upon the bone, between the adductors longus and magnus; and here the sheath of the vessel is exceedingly strong and fibrous.

Ligature of the femoral artery in the upper third of the thigh:—As the operation is now more frequently performed on this than on any other portion of the artery, we shall describe it first; and as the branches given off from the main trunk are very important, they may be briefly enumerated. Both the epigastric and circumflex arteries are sometimes given off from the femoral, just below Poupart's ligament. The profunda, a large vessel, sometimes nearly equal in size to that of the femoral itself, arises from it, at about an inch and a half or two inches below Poupart's ligament, or about midway between the pubis and the level of the trochanter minor. The other branches, though unimportant as regards the placing of a ligature, are by no means so in respect to the supply of blood to the limb after the main trunk is tied.

The femoral artery is most commonly tied at an inch or two below the profunda, as a sufficient space should be left between that vessel and the ligature to allow of a coagulum

being formed. The course of the saphena vein should be clearly ascertained before making the incision, as a wound of it, might, under some circumstances, prove highly dangerous. The patient lies on his back, with the thigh gently bent, and inclined outwards.

The pulsations of the artery having been felt as low down as the point where they become masked by the sartorius, an incision of about three inches in length is made in the line of the artery, beginning below the origin of the profunda, or about four inches below Poupart's ligament. The skin and cellular tissue being divided, the internal edge of the sartorius is seen; this being raised, a director is passed under the fascia, in order that it may be cautiously divided. The femoral vessels in their sheath will then be exposed. The point of the blunt knife, or even that of the bistoury with due care, may be employed to lay open the sheath, to the extent of an inch or more. The needle is then passed from within outwards, the vein being to the inside and rather behind, and the nerve being to the outside of the artery.

In wounds of the femoral artery, in this region, or of the profunda, as well as in spontaneous aneurism occurring high up, the vessel may also be secured between the epigastric artery and the profunda. The mode of arriving upon the sheath would be precisely the same as that just described. The ligature should be placed close above the profunda to leave as much space as possible between the ligature and the epigastric and circumflex arteries. The sheath here contains only the artery and vein, the latter a vessel of some size, and coming on the inside, somewhat in front of the artery; the nerve lies at some distance on its outside.

Ligature in the middle of the thigh:—In this situation, the femoral artery has not yet reached the tendinous canal through which it passes into the popliteal space. It was upon this portion of the femoral artery, that Hunter first applied the ligature for the cure of a popliteal aneurism. He made his incision on the inner part of the thigh, rather below its middle, continuing it obliquely across the inner border of the sartorius muscle. At the present day, the outer edge of this muscle is preferred for the line of the incision, both because the vessel is thereby more easily exposed, and the saphena vein is less likely to be injured. Some surgeons recommend a middle course; that is, to cut along the middle of the sartorius, and then to include it, either in the anterior or posterior lip of the incision, as circumstances may render it most desirable. If the surgeon is operating close upon the point where the artery is about to pass through the abductor to become the popliteal artery, his incision must then be on the outside of the sartorius. If this muscle should interfere too much with the facility of accomplishing his object, he should not, as Desault advised, divide it; enlarging the incision will answer every pur-

pose. But the decided preference given to the operation on the superior division of the artery has greatly diminished the importance of these remarks.

The incision should be at least three inches long, corresponding with the space that marks the separation between the outer edge of the sartorius and vastus internus. In some subjects, this line is not distinct, and it is therefore safer to cut a line or two within the external edge of the sartorius, so that its fibres may be exposed as soon as the cellular tissue and fascia are divided; it will be thus easy to get to its posterior surface, and detach it from the thigh, by including it in the posterior lip of the wound. By following the cellular interstice, the sheath of the vessels is easily found. On account of its great strength, some care must be taken in opening it. The best way is to scratch a small aperture through which the grooved director may be introduced, and then it may be safely slit open. The vein lies on the inside, the nerve to the outside, of the artery; its isolation from the vein is here a task of some delicacy, as they are connected by dense cellular tissue. During the whole time of the operation the limb should be gently bent, and as much relaxed as possible. The dissection will be the more easy on this account. The needle should be passed beneath the artery from within, outwards, leaving the vein to the inside. An assistant should be stationed in such a position as to be able in an instant to command the artery, by pressing it against the pubis, in case it should unfortunately happen to be wounded during the operation.

The femoral artery had been tied in cases of wounds of this vessel, long before the establishment of the principle which has governed this operation since the days of Hunter, namely, the placing the ligature on a sound portion of the vessel, and at a certain distance above the aneurismal tumour. Cases had also been recorded, where the aneurismal sac having been attacked with gangrene, the coagula and sloughs were thrown off, and the patients were cured; the femoral artery becoming obliterated. Guatani mentions a case of inguinal aneurism, which was as large as the first; it became gangrenous, and the femoral artery was obliterated for a considerable extent from the crural arch downwards. The patient was exhausted by the suppuration which followed the detachment of the eschars; but there was no deficiency in the supply of blood to the limb, notwithstanding the obliteration of the main trunk. A similar case is mentioned by M. A. Severinus; the patient recovered perfectly. Saviard mentions a case, in which Bottentuit, in the year 1688, placed a ligature on a wounded femoral artery in the Hôtel Dieu with complete success. The surgeons who were called in consultation, he states, although they were of opinion that nothing but the ligature of the wounded vessel could save the patient's life, were fearful

that he would perish from loss of blood before the opening of the artery could be found, and even though the vessels were secured they were still apprehensive that the obstruction to the circulation would be followed by mortification of the limb. Indeed so convinced were they of the desperateness of his condition, that they had the sacrament administered to him before the operation was attempted. After the ligature was placed and tied firmly, the additional precaution was taken of keeping constant pressure on the vessel by a succession of assistants for twenty-four hours. The patient had quite recovered in six weeks, and subsequently went through several campaigns. Severinus was equally successful in another case in which he applied a ligature to the femoral artery, for a wound of that vessel caused by a musket-ball: he tied it both above and below the wound.

In spite of these examples, however, and of the success attending the application of the ligature on the brachial artery, the same apprehensions as regards the mortification of the limb continued to prevail. The powers of the collateral branches to furnish a sufficient circulation continued to be overlooked, until Winslow and Haller produced their illustrations of the numberless anastomoses whereby the circulation may be continued between the upper and lower parts of the limb, after the obstruction of the main trunk. In popliteal aneurism, Haller asserted that if the course of the blood were intercepted in the popliteal artery between the origins of the upper and lower articular arteries, these arteries through their communications would be sufficient to carry on the circulation in the leg. Heister was so convinced of the soundness of the conclusion drawn from the foregoing facts and observations, that he proposed in 1744, the ligature for aneurism of the popliteal artery, to be applied in the same manner, as previously to that time it had been employed on the brachial artery. In Haller's *Disp. Chir.* Guenaud, adopting the same views, loudly condemns the practice of amputating for popliteal aneurism. Before this period, however, it would appear from a letter written by Testa to Cotugno, that Keysler, a German surgeon, had in many cases employed the ligature. Lochman, a French surgeon, operated in this way successfully at Florence in 1752, as did Birchall at the Manchester infirmary in 1757; and from this period it began to be practised in Italy under the auspices of Guattani and Magotti. The latter placed a ligature both above and below the tumour, and emptied it of its contents. It was in this way that the operation was subsequently practised in France by Chopart in 1781, unsuccessfully, and afterwards in two cases by Pelletan successfully. It would appear, from the works of Pott, Wilmer, Kirkland, and others, that this method had been employed on many occasions in this country prior to this period. From the severity of the operation itself,

however, and the unsatisfactory nature of its results, it had gradually fallen into disuse.

The precepts and practice of Hunter, opened a new era in this department of surgery; and the timidity which had so generally prevailed amongst the surgeons of the preceding age, was now completely dispelled. As the share which Hunter had in this memorable change has been claimed for others, a few observations on this point may not be unacceptable.

It has been affirmed by some French writers, that the merit attaching to the introduction of the Hunterian operation, belongs to Anel. Lisfranc, who, in his *Treatise on the Different Methods of producing the Obliteration of Arteries*, has taken some pains to clear up this point, shows that the first known method for the treatment of aneurism has been entirely overlooked by every writer on the history of this affection. This method belongs to Rufus, and is thus described by Ætius: *Si vas unde emanat sanguis profundum fuerit . . . , ubi situm ejus et magnitudinem diligenter perspexeris, noverisque numquid vena sit an arteria, vas immissa volsella extendemus, et moderate circumflectemus. Ac ubi ne sic quidem cessaverit vinculo constringemus; nonnunquam et post vinculi nexum oblique vas incidere cogimur.*¹ This quotation proves, that not only was the idea of employing the simple ligature then known, but even that the torsion of the vessel which has been of late years described as an invention of modern surgery, was then recommended.

Ætius himself describes another method, which he put in practice for an aneurism at the bend of the arm. He discovered the artery at four fingers' breadth below the axilla, and applying two ligatures, he then cut the vessel across between them; he next emptied the aneurismal sac completely, and tied the artery at this point *sicut priorem*, an expression which, according to the interpretation of M. Dézeimiris, seems to say that he also applied two ligatures upon the artery below the tumour.

Paul of Egina's method of treating spontaneous aneurism, *si ex arteria dilatata tumor obvenit*, was to expose the vessel by a longitudinal incision, and by means of a needle, pass a double ligature under it, previously plunging a bistouri into the tumour. Though the text is somewhat obscure, it may very naturally be supposed that the ligatures were placed above and below the tumour, and that the sac was opened between them. Here then, observes Lisfranc, is a proof that the method chiefly followed during the 18th century, may be traced back to Paul of Egina.

Avicenna mentions the simple ligature for the wounds of arteries, judiciously recommending that it should be applied between the wound and the heart; and adds, that if the blood should issue from the inferior portion of the wounded vessel, that a second ligature should be applied.

¹ Ætius, lib. xiv. cap. 52.

Paré, speaking of an aneurism near the shoulder-joint, which had been imprudently opened by a barber, gives the following advice : “ Partant je conseille au jeune chirurgien, qu’il se garde d’ouvrir les aneurismes, si elles ne sont fort petites, et en parties non dangereuses, coupant le cuir au dessus, le séparant de l’artère ; puis on passera une esguille à séton, enfilée d’un fort fil, par sous l’artère aux deux costés de la plaie, laissant tomber le filet de soy-même, et ce faisant, nature engendre chair qui sera cause de boucher l’artère¹. ”

Guillemeau, a pupil of Paré, gives an account, in the following words, of the operation he performed on the son of M. Belleville : “ Auquel après une saignée faite au ply du bras, lui était survenu un petit aneurisme, qui par succession de temps était accru de la grosseur du poing, auquel enfin le sang contenu en iceluy se groumela ; ce qui fut cause d’engendrer quelque commencement de pourriture en ladite tumeur, comme il s’aperçut par le cuir qui avait changé sa naïve couleur en noirceur et lividité, *estant même altéré et ouvert* ; pour à quoi obvier et au grand flux de sang principalement qui s’en pourrait suivre, avec deperdition d’esprits, si l’ouverture se faisait plus ample, je proposai aux médecins et aux chirurgiens le seul remède pour obvier à ce mal, qui était de lier l’artère plus haut que l’aneurisme qui était au ply du bras, à laquelle opinion enfin chacun s’accorda. Premièrement je remarquai sur le cuir l’artère en la supérieure et intérieure partie de l’avant-bras, ainsi qu’elle descend de l’aisselle au ply du bras, trois doigts au dessus d’icelui ; et en cette même partie suivant ce que j’avais remarqué, je fis une légère incision en long au cuir, qui était comme séparé à l’endroit de l’artère où elle se rencontre au toucher, et l’ayant ainsi découverte, passai par dessous avec une grosse esguille courbe une petite fisselle desliée, puis avec icelle fisselle je liai ladite artère à double nœud. Cela fait, tout le sang groumelé et autre caillé contenu en la tumeur fut ôté, puis les parois de la tumeur furent lavées avec eau-de-vie à laquelle j’avais fait dissoudre un peu d’Egyptiac pour corriger la pourriture, ja commencée en cette partie ; un mois après le malade fut parfaitement guéri sans être aucunement estropié ; de quoi j’ai été infiniment esmerveille. ”

The operation which Anel performed a century later, differed from Guillemeau’s only in regard to the sac being left untouched ; but in both, the ligature was placed on the vessel just above the sac, and it appears that Guillemeau did not by any means consider the emptying of the sac as an essential step of his operation, since he adds to his description of it, “ Si en quelque autre partie extérieure il se présente au chirurgien pareil aneurisme, il peut sûrement découvrir le corps de l’artère vers sa racine et partie supérieure et la lier de même façon *sans autre cérémonie* ². ”

¹ A. Paré, liv. vii. c. 34. De l’Aneurisme.

² Guillemeau, p. 699.

Now, on neither of these occasions was the principle involved in the Hunterian operation as much as hinted at. The surgeons of the 17th and 18th centuries did not possess that knowledge of the diseases of arteries, which might have led to the adoption of so important an improvement as that with which the name of Hunter is irrevocably identified. Nay, the case operated upon by Dessault in 1785, cannot even be quoted as an illustration of the principle, for Dessault operated on the *popliteal* artery, just above the tumour, as did Guillemeau and Anel on the brachial artery. Hunter tied the *femoral* artery for popliteal aneurism. In so doing, his purpose was obvious : he was aware that the disease in the coats of the artery, upon which the formation of the aneurismal tumour depended, often extended for some distance along the vessel, and he therefore placed his ligature at a distance above the tumour, in order that it might bear upon a sound portion of the arterial trunk, well knowing that the contents of the aneurismal sac might be absorbed. The question therefore is not one of dates, but of facts, and the difference between the two modes of operating, which on one side have been gratuitously assumed to be identical, may be thus summed up : Anel’s operation, performed at the beginning of the 18th century, preceded Hunter’s by seventy years, led to no result, and was all but forgotten ; Hunter’s led the way to some of the most brilliant achievements of surgery, and changed the whole practice of our art in regard to this particular class of diseases.

In the thigh, as in other situations, aneurisms have been known to undergo the spontaneous cure, the tumour either inflaming and suppurating, or the sac becoming converted into a fibrous knot, without any apparent inflammatory symptoms. Instances might be collected, in which these favourable terminations of spontaneous aneurisms have been observed to take place, either with or without local treatment, such as the application of ice, evaporating or astringent lotions, leeches, &c. Even wounds of the femoral artery have been known to undergo the same process of cure. Larrey speaks of a serjeant of the guard, who, in 1817, had a sword wound in the upper part of the right thigh ; a circumscribed false aneurism was the consequence ; he was however, soon cured by Valsalva’s treatment combined with cold local applications.

Compression has also been employed, with now and then a favourable result. Guattani succeeded in obliterating the femoral artery, by keeping up pressure upon it against the branch of the pubis. Brasdor’s method has also been employed on the femoral artery in inguinal, or rather iliac aneurism, but without success.

In whatever part of its course the femoral artery may be tied, the collateral circulation unless it shall have been extensively obliterated, will be found sufficient for the nourishment of the limb. In some cases even the

tumour has been observed to pulsate anew at some interval after the ligature had been applied. The instances mentioned by Pott and Guerin, in which the popliteal tumour continued to increase after the ligature had been applied, do not, as was then supposed, prove that the ligature had not been placed on the vessel. We now know that the recurrent circulation may be sufficient to renew the pulsation of the tumour; but compression and rest, in these cases, will in general be found successful. Monteith of Glasgow mentions a curious case of aneurism in which two months after the femoral artery had been tied the tumour had become much reduced in bulk, and all but consolidated; in this case however the pulsations returned, and the tumour began again to increase. It was checked and ultimately cured, without a second ligature, by the means just mentioned.

of the lumbar nerves, crossing the iliac fossa on the outside of the artery.

No. 2. The femoral artery, just below Poupart's ligament, is seen giving origin to the circumflex. *a*, the artery; *b*, the vein to its inside, and in the same sheath; *c c*, the ligature passed under the artery; *d*, a blunt hook retracting the outer lip of the wound.

No. 3. Ligature of the femoral artery at the place of election, close upon the point where it passes under the internal border of the sartorius. *a*, the artery; *b*, the vein; *c c*, the ligature passed beneath the artery; *f*, a blunt hook, retracting the outer lip of the wound. The sheath of the femoral vessels is laid completely open, to show the relative position of the artery, vein, and nerve. The same extent of opening would be not only unnecessary, but improper in the operation for tying the vessel.

No. 4. The femoral artery is here exposed at the point where it is about to become the popliteal. The external edge of the sartorius is carried to the inside of the thigh, the vastus internus to the outside. *a*, the artery; *b*, the vein; *c c*, the ligature passed beneath the artery; *d d*, the sheath of the vessels fully laid open; *e*, and *f*, a blunt hook and retractor.

Fig. 93.

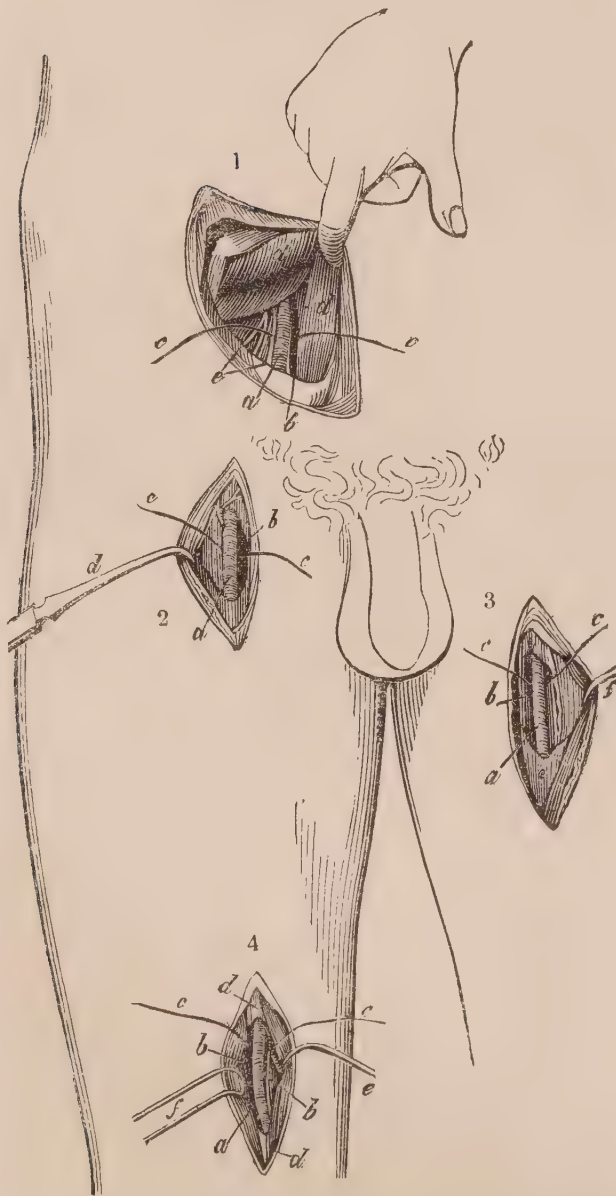


Fig. 93 shows the operations for tying the external iliac artery and the femoral artery at three different points.

No. 1. The lower edge of the abdominal muscles having been divided, and the peritoneum detached from the iliac fossa, both are raised upon the fingers of the assistant. *a*, the external iliac artery; *b*, the vein lying to its inside; *c c*, the ligature passed under the artery; *d d*, the bag of the peritoneum; *e*, branches

EXTERNAL ILIAC ARTERY.

The common or primitive iliac arteries from their origin at the bifurcation of the aorta, give rise to several important vessels, which supply the internal and external parts of the pelvis, and the lower extremities. The common iliac extends in direction downwards and outwards from the middle of the fourth lumbar vertebra to the sacro-iliac symphysis; at this point, it divides into the internal iliac which descends at once into the pelvis, and the external iliac, which, coursing along the brim of the pelvis, passes outwards and downwards under the middle of Poupart's ligament, there to become the femoral artery. In this course it runs parallel to the internal border of the psoas muscle, having the iliac vein to its inside and somewhat behind it. The anterior crural nerve lies to its outside, and separated from it by the psoas muscle; another small nerve lies either on the front of the artery, or between it and the vein. It is bound down in its situation by the iliac fascia which forms its sheath, and the lymphatics ascending under Poupart's ligament entwine themselves on its surface. It is crossed by the spermatic vessels, and the whole is covered by the peritoneum, which is united to these several parts by loose cellular tissue. In passing under Poupart's ligament, it gives off the epigastric and circumflex arteries.

Ligature of the external Iliac Artery:—This operation was first performed by Abernethy in 1796, on a patient who had had two aneurisms in succession, the first of the popliteal artery, which was cured by the Hunterian operation; the second of the femoral artery of the opposite limb, high up in the groin. Abernethy first placed a ligature on Brasdor's plan, on the artery below the tumour. Hæmorrhage came on the fifteenth day after the operation, and as a last resource, he immediately resolved to tie the iliac artery itself. He accordingly made an incision in the abdominal integuments, and in the line of the artery, of about three inches in length. The aponeurosis of the external oblique was thus laid bare,

and divided from Poupart's ligament in the direction of the external incision. He next passed his finger beneath the margins of the internal oblique and transversalis, and divided them upon it, the finger protecting the peritoneum. He was then at liberty to detach the peritoneum, and reach the vessel. After separating the artery from the vein, he passed a ligature carefully around it, and tied it as high as an inch and a half above Poupart's ligament. In another case in which Abernethy operated, he made his incision, not upon the line of the artery itself but somewhat more externally, in order not to wound the epigastric artery. As he adhered to this method afterwards, it will perhaps be proper to describe it more particularly.

The patient is made to be somewhat inclined to the side opposite to that on which the operation is to be performed, in order to relax the abdominal muscles covering the tumour, and diminish the pressure of the intestines upon that side. An incision is then made half an inch to the outside of the abdominal ring, beginning just above Poupart's ligament and ascending somewhat obliquely in the direction of the artery to the height of three inches. The aponeurosis of the external oblique having been divided, the index finger of the left hand is introduced beneath the lower border of the external oblique and transversalis; a concave bistoury is then guided on the finger, and they are divided to the extent of an inch and a half. The peritoneum is then cautiously detached until the pulsations of the artery are felt; its isolation and ligation are then effected as already described, care being taken to carry the point of the needle from within, outwards, in order to protect the vein from injury.

Fig. 94.

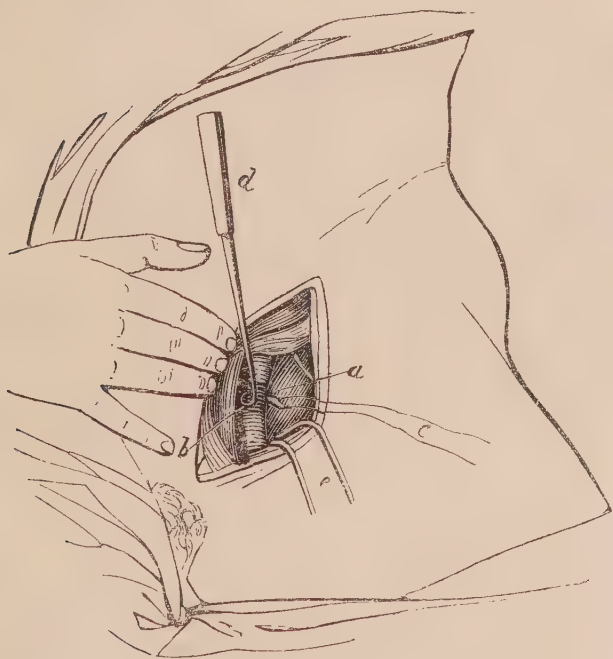


Fig. 94. Mr. Norman's plan for making the incision for placing a ligature on the external iliac artery. The superior lip of the wound is held open by an assistant, who sustains the abdominal viscera at the same time. The skin, muscles, and a fold of the peritoneum are thus held up. The lower lip is also

retracted, exposing the external iliac fossa, upon which one of the lumbar nerves is seen. *a*, the external iliac artery raised on an aneurism needle, *d*; *b*, the external iliac vein; *c*, the ligature; *e*, a retractor. The epigastric artery is given off from the inner side of the vessel at the inferior angle of the wound, where it may be tied in case of accident; a small nerve also accompanies the artery, which should not be included in the ligature.

Sir A. Cooper's method is somewhat different, and is thus described by Mr. Hodgson. "A semilunar incision is made through the integuments in the direction of the fibres of the aponeurosis of the external oblique muscle. One extremity of this incision will be situated near the spine of the ilium; the other will terminate a little above the inner margin of the abdominal ring. The aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent, and in the direction of the external wound. The flap which is thus formed being raised, the spermatic cord will be seen passing under the margin of the internal oblique and transverse muscles. The opening in the fascia which lines the transverse muscle through which the spermatic cord passes, is situated in the mid-space between the anterior superior spine of the ilium, and the symphysis pubis. The epigastric artery runs precisely along the inner margin of this opening, beneath which the external iliac artery is situated. If the finger therefore, be passed under the spermatic cord, through this opening in the fascia, it will come into immediate contact with the artery, which lies on the outside of the external iliac vein. The artery and vein are connected by dense cellular tissue, which must be separated, to allow of the ligature being passed round the former."

Mr. Norman of Bath, who has operated according to both modes, has the following judicious appreciation of them. "The objection to Sir A. Cooper's mode of operating in cases where the tumour extends high up, is by no means well founded; for the lower part of the bag of the peritoneum, lying on the edge of Poupart's ligament, must in every case be exposed and detached, in order to get at the artery, which lies behind the posterior part of that membrane, and this is most easily effected by an incision in the direction of Poupart's ligament; whilst two thirds of the longitudinal incision are made on a part of the peritoneum, which lines the abdominal muscles, and the lower portion only of the incision reaches that part of the membrane, which is to be separated. The consequences of this are, that the peritoneum is in much greater danger of being wounded, and that the probability of a hernia forming after the cure, is much increased by the extensive division of the oblique muscles." (*Med. Chir. Trans.* vol. x. p. 101.)

Another modification of this method was proposed by Bogros, who had so much distinguished himself in his short but brilliant career as *Chef de travaux anatomiques* to the Faculty of Medicine of Paris. He made an incision, just above Poupart's ligament about two or three inches long, the extremities of which were

about the same distance from the spine of the ilium on the outside, as from the angle of the pubis on the inside. This brought into view the aponeurosis of the external oblique, which was divided on a director, to the same extent as the external incision, and parallel to Poupart's ligament. The slight connection of the cremaster muscle with the femoral artery was then broken up with a blunt knife, and both the muscle and the spermatic vessels were carried towards the pubis. The *fascia transversalis*, with the opening through which the spermatic cord passes into the inguinal canal, then presents itself. This opening is dilated with the finger, until the epigastric artery, which lies just behind it, is exposed. Following this artery with the finger towards its origin, the iliac artery is easily discovered.

During the whole time of the operation, but more especially after the muscles have been divided, the walls of the abdomen should be kept perfectly relaxed, and the patient should avoid any sudden movement, or effort, as otherwise the peritoneum may be wounded.

Each of these methods has its advantages and disadvantages. Abernethy's first method is reproached with an extensive and unnecessary exposure of the peritoneum, which on the other hand is compensated for, by the facility which it gives for reaching and tying the vessel. Those of Sir A. Cooper, Mr. Norman, and Bogros, in which the wound is prolonged, it is said uselessly, towards the spine of the ilium, expose less to lesion of the epigastric artery, and to subsequent hernia; but the facility of placing the ligature is not so great, and the vessel cannot be reached to as great a height as in the former method. This is particularly the case in Bogros' modification. These inconveniences however are easily obviated by prolonging the external angle of the incision obliquely upwards. Whatever method may be adopted, the importance of respecting the epigastric artery should not be lost sight of, as some of the cases of this operation have proved fatal solely in consequence of hæmorrhage from a wound of this vessel. Dupuytren lost a patient upon whom he operated in 1821 in this way. In placing the ligature, the epigastric artery should be left below it. Beclard lost a patient from neglecting this point: the epigastric artery came off above the ligature, and the formation of a sufficient coagulum having been thus prevented, a fatal hæmorrhage occurred on the separation of the ligature.

English surgeons allow an inch at least to intervene between the ligature and any collateral branch, either above or below it, which from its size might convey blood into the tumour, and thus keep up its pulsations or prevent the formation of a coagulum. The dangers of a different practice are now too well understood, for any intelligent practitioner to incur them unnecessarily.

The method of operating may however be less a matter of choice than of necessity, as

the size, state, and situation of the tumour may determine.

In regard to the obliteration of the iliac artery, certain facts were known at an early period of the last century, which might have pointed to the probability of a successful result from the application of a ligature upon that vessel. Guattani's and Scarpa's injections had clearly established, that although a ligature had been previously placed on the external iliac artery, the coloured fluid passed freely into the arteries of the thigh and leg. In Guattani's case, already mentioned, in which he cured an inguinal aneurism by compression, both the femoral and iliac arteries were obliterated. This case dates as far back as 1767. In a case of Gavina's, which he operated on in 1755, on examining after death, the iliac artery was found completely impermeable. Baillie observed another case in which the obliteration of the femoral artery was continued up into the pelvis, while the limb was nourished as usual. Clarke observed a similar case in 1784. Notwithstanding the obvious tendency of these and other similar indications, it was only the danger of immediate death to his patient that compelled Abernethy to overlook the remoter dangers of mortification of the limb, or consecutive hæmorrhage, when he first performed this bold operation in 1796. He was unsuccessful in his two first cases, but in his third case, he was completely successful. Abernethy was followed by Freer of Birmingham in the same year 1806, and Tomlinson of the same town in 1807. The latter had a second successful case in 1809. From this period, the practice spread rapidly. In the next year, the external iliac was tied for the first time in France by Delaporte of Brest, and this case in all likelihood would have been successful, had the ligature been had recourse to at an earlier period. The ravages produced by the tumour itself, were so extensive, that the inflammation which followed in the diseased mass, proved fatal. Goodlad had a successful case in 1811, and Dorsey of Philadelphia, another in the same year. In 1812, Bouchet of Lyons operated with success on a patient, who died of an aneurism in the opposite limb, in the following year. In the same year, Albert's patient died of tetanus, on the 20th day after the operation. Mr. Norman and Mr. Brodie had each a successful case in 1813, and Mr. Lawrence one in 1814. Mr. Samuel Cooper states, out of 25 cases, that he only knew of three in which the limb was attacked with gangrene; and these three were the patients of Sir A. Cooper, Bouchet of Lyons, and Mr. Collier.

The operation of tying the external iliac is now as fully accredited in surgery as that of any other artery. It has been attended with a fair average of success in comparison with other operations of a similar kind. Indeed Mr. Wilmot remarks that as compared with the ligature of the artery in the thigh, the ligature of the external iliac artery presents more recoveries in proportion to the number

of times it has been performed. Up to the present time, it is estimated to have been successfully employed in about forty cases, some of which have been attended with circumstances more or less worthy of remark. The case of Mr. Kirby of Dublin was followed by hernia which made its appearance through the line of the incision of the abdominal muscles. In Dr. Post's case, the peritoneum was so thickened and diseased, that he could not raise it from the subjacent parts, and was obliged to make an opening in it. The protruding viscera were then pushed back, and with a needle the ligature was introduced under the artery, the peritoneum being also included in the ligature. The patient nevertheless did well. In Mr. Newbiggin's case, there was inguinal and popliteal aneurism of the same limb, and both were cured by the ligature of the external iliac. Both the external iliacs were tied by Mr. Tait, the first on the 8th of May 1825, the second on the 16th of April 1826, and with perfect success, notwithstanding that the peritoneum was opened on one side. Arendt was much more bold; for he tied both the iliacs in succession, with an interval of eight days only between the operations, and was also successful.

The aneurisms of the external iliac artery are almost always spontaneous. Velpeau however relates a case of traumatic aneurism or rather of a wound of this vessel, in which by temporary compression time was obtained for placing the ligature. The patient was a robust young man, 17 years of age, who while cleaning a table in a dark place had inadvertently stabbed himself in the groin with a ham-shop knife, opening the iliac artery transversely about a quarter of an inch above the epigastric. The blood gushed out in torrents. Drs. Layraud and Durand, who were on the spot almost immediately, compressed the artery, two inches above the wound, and thus stopped the hæmorrhage while a messenger was dispatched for M. Velpeau. On his arrival, he at once laid bare the vessel and tied it. The ligature was not discharged till the 35th day, and the patient recovered perfectly. This interesting case illustrates two points: 1st, that a previous dilatation of the vessels, which are to carry on the circulation after the ligature of the main trunk, is not indispensably necessary to protect the limb from liability to gangrene, and 2d, that compression may be successfully kept up on a vessel of this magnitude, until efficacious succour may be obtained.

Compression, conjointly with general treatment, has in a few instances been successfully employed in inguinal aneurism. In Guattani's case, the pressure was made upon the artery itself, which he had previously laid bare, where it passes over the branch of the pubis.

Ligature of the Epigastric Artery:—If this vessel were wounded in the operation for exposing the external iliac, it would be the surgeon's duty to secure it, before he proceeded further. But it may also be wounded

under other circumstances. Bogros gives the following rule for cutting down upon it. An incision two inches long, is made just above and parallel with Poupart's ligament, and about equidistant from the spine of the ilium, and symphysis of the pubis. As soon as the aponeurosis of the external oblique is exposed, a director is passed under its inferior edge, and it is divided in the same direction as the external wound. On raising the spermatic cord, the orifice of the internal ring is seen; this is dilated with the finger, and the artery is found behind its internal edge and sheltered by the fascia which forms that edge. The ligature is easily applied; but it should be placed close upon the wound, in order to leave space for the coagulum between it and the main trunk.

Fig. 95.



Fig. 95. *Aneurism of the external iliac artery, forming an enormous tumour in the groin.*

INTERNAL ILIAC ARTERY.

The course of this vessel is nearly perpendicular from the point where it is detached from the primitive iliac, in front of the sacro-iliac symphysis, down to the sacro-ischiatic notch. It is accompanied by the internal iliac, or hypogastric vein. The ureter passes obliquely in front of its origin.

Spontaneous aneurism of the internal iliac is so rare, that only one case of it is recorded. This case was observed by Sandifort. But its branches, the external ones more especially, are exposed to injuries from wounds which require the interference of the surgeon; and there are several instances on record of patients dying of hæmorrhage from traumatic or spontaneous aneurisms of the gluteal artery, from the want of timely succour.

Ligature of the internal Iliac Artery:—My friend Dr. Stevens of Santa Cruz, was the first to place a ligature on this vessel, in 1812, for an aneurismal tumour situated in the buttock, and which in the space of nine months, had attained to a very considerable size. The patient was a female slave. Having previously satisfied himself of the practicability

of the operation, by a trial on the dead body, Dr. Stevens made an incision about five inches in length in the lower lateral part of the abdomen, parallel with and half an inch on the outer side of the epigastric artery. The skin, fascia, and abdominal muscles having been successively divided, and the peritoneum separated from its loose connexion with the iliacus and psoas muscles, as high as the division of the common iliac artery, he felt for the internal iliac, and insinuating his fore-finger between it and the vein, pressed it between his finger and thumb. The pulsation in the aneurism ceased at once, and the tumour began to diminish. The ligature was then passed round the artery, and tied about half an inch from its origin. The tumour disappeared almost immediately after the operation, and the wound healed kindly. The ligature came away three weeks after. The loss of blood during the operation did not amount to an ounce. This woman lived nearly twenty years after; at her death, a preparation of the parts was made, which is now deposited in the Museum of the College of Surgeons of London.

In the year 1817, Mr. Atkinson of York tied the internal iliac for an aneurism of the gluteal artery. The patient was a young muscular bargeman. The tumour was situated under the gluteus muscle, and had been coming on for nine months, in consequence of his being struck with a stone. Mr. Atkinson performed the operation in the same manner as Dr. Stevens; but the artery was in this instance situated at a greater depth, as it required the full length of his fingers to reach it. The pulsation of the tumour was arrested immediately on pressing the artery between the ligature and the fore-finger. This point once ascertained, it was unnecessary to repeat it for the satisfaction of the assistants and pupils; and had the vessel been less disturbed for this purpose, perhaps the operation would have been attended with a different result. The patient sank, partly from hæmorrhage, and partly from exhaustion, three weeks afterwards. The ligature was completely detached though it still remained in the wound.

Averill, in his *Operative Surgery*, also mentions a case in which the internal iliac was tied by a Russian army-surgeon, and on whom the Emperor Alexander settled a pension as a reward for the skill he displayed in the treatment of the case.

An American surgeon, Mr. Pommeray White, has also tied this vessel for a gluteal aneurism. His incision extended in the shape of a half moon, to the length of seven inches, beginning near the umbilicus, and terminating near the inguinal ring. He tied the artery about an inch from its origin, and united the wound with points of suture and adhesive straps. The case was successful.

The operation might also be performed by prolonging the incision made for placing the ligature on the external iliac.

Ligature of the Gluteal Artery:—The gluteal artery, which may be regarded as the external continuation of the main trunk, owing to its exposed situation, is liable to be wounded. Dr. Jeffray of Glasgow was consulted in a case of this kind: he recommended the wound to be dilated, and the vessel secured where it had been injured. His advice was not adopted till too late, for while the preparation was being made for the operation, the tumour burst, and the patient died of hæmorrhage.

In a similar case, John Bell dilated the wound, and tied the artery with complete success; and Mr. Rogers has published a case in which he was also successful.

The dilatation should be made with caution: Theden mentions a case, where in dilating a gun-shot wound, the gluteal artery was wounded by the surgeon, and the patient lost his life.

Mr. Lizars proposes the following plan for cutting down on this vessel:

The patient is made to lie on his belly, the thigh is extended, and the toes turned inwards. An ideal line is drawn from the superior posterior spine of the ilium to the middle of the space between the tuberosity of the ischium and the great trochanter. The artery emerges from the pelvis at the point where the two superior thirds join the inferior third of this line; here it lies in the space between the gluteus medius and the gluteus maximus. The incision, however, should not be made in this line, as it would divide the fibres of the gluteus maximus transversely; it should be made in the direction of those fibres, and in a line nearly corresponding with that of the sacrum and great trochanter, and passing over the point of emersion from the pelvis already indicated. The integument, and fibres of the gluteus maximus having been divided, and the muscle raised, the artery will be found immediately below the upper border of the great ischiatic notch. The length of the incision must vary according to the corpulency of the patient.

Mr. Brooke states that he succeeded by compression, and the exhibition of digitalis and laxatives, in dispersing a tumour which he believed to be an aneurism of the gluteal artery.

PRIMITIVE, OR COMMON ILIAC ARTERY.

In this, as in the case of other large arterial trunks, instances of spontaneous obliteration had been observed before any one had the hardihood to propose placing a ligature upon it. Dr. Goodison of Wicklow, while dissecting at the Pitié in 1818, found a long-standing and complete obliteration of both the common iliacs, without any apparent injury to the lower extremities. Sir A. Cooper's experiments on dogs had already demonstrated that the common iliacs might be tied in these animals, without producing gangrene of the corresponding extremities.

Valentine Mott of New York was, however, the first who tied the common iliac with success in 1827. The aneurism for which he operated, had been formed suddenly, and had in the short space of ten days attained to a considerable size, producing dreadful pain, and uplifting the walls of the abdomen at every pulsation. The tumour comprehended the whole of the external iliac, and even ascended a little above the origin of the internal iliac.

Fig. 96.

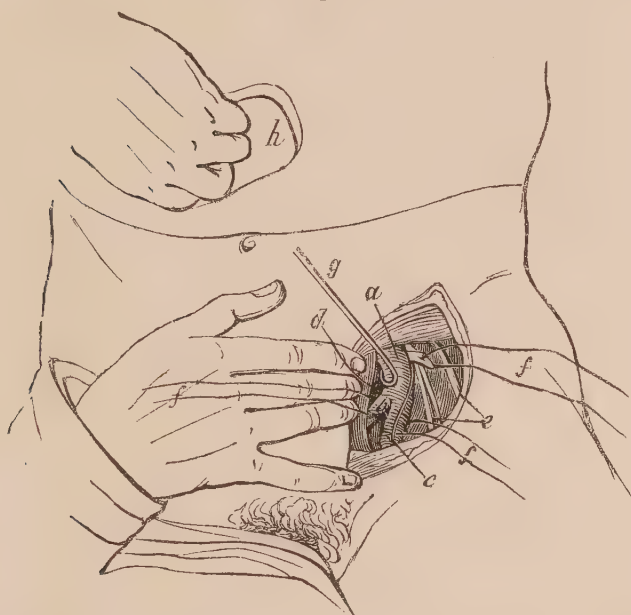


Fig. 96 represents the incision of the abdominal walls; the internal border of the wound is retracted by the assistant's right hand, which supports the intestines at the same time, while his left hand holds a square pad, *h*, on the track of the aorta, ready to command the circulation, by compressing the artery against the lumbar vertebrae. The peritoneum, *d*, detached from the iliac fossa, and exposing the lumbar nerves which cross that space, is seen drawn across the upper part of the wound, and pressed also beneath the fingers of the assistant. In the centre of the wound, *a*, the great arterial trunk itself is seen bifurcating into the internal and external iliacs; the trunk or common iliac is raised on an aneurism needle, *g*, and ligatures, *fff*, are placed on each division of the arterial tree. The external iliac vein, *c*, lies to the inside of the artery, and is crossed by the internal iliac artery. The satellite nerve is seen running down the surface of the main trunk, and should not be included in the ligature.

Ligature of the Common Iliac.—Dr. Mott made a semicircular incision, which extended from the outer side of the inguinal ring, about half an inch above Poupart's ligament, to two inches above the spine of the ilium. The peritoneum was raised from the aneurismal tumour, and a ligature was placed on the artery a little way below the bifurcation of the aorta. The pulsations ceased immediately in the tumour, and the limb became cold; the natural heat returned about an hour after, and the patient recovered perfectly without showing any symptom either of hæmorrhage or gangrene.

In the following year, Mr. Crampton of Dublin tied the common iliac, and in all probability would have also saved his patient, had he employed the ordinary silk ligature. The patient died of hæmorrhage on the

fourth day. It would appear from the autopsy, that the ligature of animal matter, which Mr. Crampton thought deserving of a preference on this occasion, had either slipped from the artery or been dissolved before it had become obliterated. The circulation, heat, and sensibility of the limb, were however, as in Mr. Mott's case, fully re-established long before this unfortunate event.

Dr. Gibson of Baltimore also tied the common iliac, but without success, for a wound of this vessel.

If the progress of an aneurism were slow, Valsalva's treatment ought however to be first had recourse to, and in some instances, perhaps Brasdor's method might find its application.

ABDOMINAL AORTA.

The aorta, after passing the diaphragm, gives off a considerable number of very important branches; but, at its lowest part, after giving origin to the inferior mesenteric branch, it runs to its bifurcation in front of the lower part of the fourth lumbar vertebra, a space of about two inches, without detaching any other branch. This portion of the aorta has been tied; and although the propriety of carrying out the principles of surgery, may in regard to this operation be questioned, either generally or in relation to a given case, still the possibility of the circulation being carried on, and the lower extremities being duly nourished after a ligature has been placed on the aorta, cannot be, for a moment doubted. The body is indeed a vast net-work of vessels, with communications almost innumerable between one set or division of these vessels and another, and the blood therefore, when interrupted in the main channel, instead of being dammed up and arrested, is forced through the collateral vessels until it reaches the main trunk again at some point below the obstruction; the route it has taken being, it is true, more circuitous, but not the less certain. The supply of a sufficient quantity of blood to nourish the lower limbs is regarded almost as a matter of certainty, in experimenting on dogs, when a ligature is placed on the abdominal aorta. Sir A. Cooper has fully established this fact, as he has frequently tied the aorta in dogs, and always found that the blood was readily carried by the anastomoses into the posterior extremities.

This operative proceeding however, it must be admitted, must almost always be had recourse to, under great disadvantages, so that any analogy between it, and the ligature experimentally applied on animals, cannot well be established. The nearest approach to such an analogy would be found in a wound of the vessel; yet if the wound were large, there would not be time to give the patient this chance for his life, and on the other hand, if the wound were small, the hæmorrhage might proceed so gradually, that the diagnosis of the wound of the aorta could scarcely be estab-

lished with such a degree of certainty, as to justify the surgeon in undertaking so bold an operation.

In a case of spontaneous aneurism, such as that in which Sir A. Cooper operated, the chances of success are again materially diminished by the progress which the disease must have made, before the surgeon would think of proposing so bold a step, and the extensive obliteration which a wide spread tumour may have produced amongst the collateral vessels.

Nevertheless we by no means intend to say, that the ligature under no circumstances should be placed on the aorta. The subjoined case, while it calls forth our admiration of the moral courage of the man, will present to the minds of most people, as it certainly does to our own, a strong justification of the measures, which Sir A. Cooper resorted to, as the last resource to save the life of a fellow-creature.

A porter, aged 38, was admitted into Guy's Hospital, April 9, 1817, for an aneurism in the left groin, situated partly above, and partly below Poupart's ligament. The swelling was considerably diffused, and pressure upon it was productive of great pain. On the third day after his admission, the tumour was double its former size, and the pulsation had become less distinct. The blood could be felt within the sac, which was so large, that no operation was practicable without opening the peritoneum. Sir A. therefore waited in order to give the man the chance of a spontaneous cure. Notwithstanding venesection and compression were employed, the tumour continued to increase, and on the 20th June, a bleeding took place from a point of it, upon which a slough had formed. The bleeding was renewed at intervals, and on the 25th he was so much exhausted from loss of blood, that his fæces were voided involuntarily, and his immediate death was only prevented by keeping pressure upon the aperture. At nine o'clock in the evening, Sir A. made a small incision into the sac above Poupart's ligament, and introducing his finger, tried if it were practicable to pass a ligature round the external iliac artery within the cavity; but this was found to be impossible, as instead of the vessel, "only a chaos of broken coagula" could be perceived. At the moment of withdrawing the finger, two students compressed the aorta against the spine, and the incision was then closed with a dossil of lint. He now determined to apply a ligature on the aorta itself, and made an incision three inches long into the linea alba, giving a slight curve to avoid the umbilicus, which was just opposite the centre of the incision. A small aperture was next made into the peritoneum, and introducing his finger into the abdomen, he enlarged with a probe-pointed bistoury, the opening of the peritoneum to nearly the same extent as the external wound. Neither the omentum nor the intestines protruded, and during the progress of the operation, only

one small convolution projected beyond the wound. An opening was scratched with his finger-nail in the peritoneum covering the aorta, and on the left side of the vessel, passing the finger between the aorta and the spine till it came through the peritoneum on the right side. The needle was then passed under the aorta, and the ligature tied, care being taken at the same time to keep the noose clear of the intestines. The wound was closed with the quilled suture, and adhesive straps. The pulse during the operation and for an hour after was 144. The sensibility of the right side was greatly impaired. In the night he complained of pain in the abdomen, but there was no tenderness on pressure. At first the lower extremities were cold, but the natural heat soon returned; the sensibility still, however, continued imperfect, more especially on the left side, where it was almost null. At eight o'clock next morning, the right limb had nearly recovered its natural warmth; and at noon, its temperature was 94° , while that of the left, the aneurismal side, was only $87\frac{1}{2}^{\circ}$. He complained of pain in the loins, and his urine and fæces were discharged involuntarily. His pulse fell, he vomited, and had cold perspiration. He died between one and two o'clock on the second day, the aneurismal limb having previously assumed a livid appearance, particularly around the aneurism, and its temperature having gradually declined again: that of the right, however, remained natural.

On examining after death, there was not the slightest appearance of peritoneal inflammation, except just at the edges of the wound: the omentum and intestines still retaining their natural colour. The ligature remained firmly placed about three-fourths of an inch above the bifurcation of the aorta. The superior clot was more than an inch long; that filling the vessel below the ligature, extended an inch down the common iliac on the right side; and the third clot on the left side, extended from the ligature to the aneurism.

The patient died, not from peritoneal inflammation, but from the want of circulation in the aneurismal limb; a sufficient circulation was re-established in the sound limb, and it may be fairly presumed that the same would have been the case of the other limb, had not the vital powers, that of the heart especially, been weakened by loss of blood, and had not many of the collateral channels, upon which a due supply depended, been obliterated by the extension and pressure of the aneurismal tumour.

One end of the ligature was left hanging out of the wound. Sir A. Cooper has since stated in his lectures, that if he ever should have to perform the operation again, he should tie the aorta from the side, and behind the peritoneum, the cavity of which he would not open.

Mr. James of Exeter performed the operation of placing a ligature on the aorta on the

5th July 1829, after having previously on the 2d June, attempted to effect the obliteration of the external iliac artery, by placing a ligature on the capillary side of the tumour. The patient survived the operation but a few hours. On examining after death, the iliac artery was found to be divided into two trunks, so that Brasdor's plan was not followed as Mr. James had imagined; it had, however, produced a temporary diminution in the force of the pulsations; and had this anomalous distribution been suspected, a second ligature might perhaps have led to a different result.

The aorta at various points of its course has been found obliterated. M. A. Severin speaks of a person in whom he found the aorta completely plugged up by a solid concretion, just below the emulgent arteries. Dr. Graham of Glasgow published in *Med.-Chir. Transactions*, an account of a case in which the aorta was found completely obstructed just below the *canalis arteriosus*. Dr. Monro mentions an instance in which the aorta was obliterated by the remains of an old aneurism, just above the common iliaes. In the case already mentioned, as having been observed by Dr. Goodisson, the obliteration had extended from the aorta to the iliaes. Other examples of this obliteration have been observed by Mr. Crampton, Sir A. Cooper, Larrey, Mr. Key, &c. These obliterations having occurred without affecting the nourishment of the lower extremities, furnish an additional proof of the power of the anastomoses to supply a sufficient circulation in place of that which had been obstructed. The spontaneous cure of aneurism of the abdominal aorta may therefore be accomplished, and should in all cases of this nature, be attempted by internal means, such as the exhibition of antimony, digitalis, low diet, general bleeding, &c., as well as by external applications, such as cold, sanguisuction, compression, rest, &c.

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(Wm. B. Costello.)

ANEURISM BY ANASTOMOSIS. (See NÆVUS, NÆVI MATERNI.)

ANGEIOLEUCITIS, from ἀγγεῖον, *a vessel*, and λευκός, *white*; *inflammation des tissus blancs*, Fr.; *inflammation of the lymphatics*. The domain of medicine and surgery has, within the last half century, been greatly enlarged by the successful study of the inflammation of arteries and veins. In this respect, however, the knowledge derived from the investigation of the venous, has been far more important than from that of the arterial system. Destined to bring back to the heart the blood that had been sent out by the arteries, and which had become altered in its properties, and at the same time, to offer a receptacle for

all recrementitial matter, and for most of the molecules that are to make their way into the circulating torrent, the veins also serve as conductors to innumerable causes of disease, whilst they may be themselves the seat of various alterations. We find accordingly, at the present day, that the veins have acquired immense importance in general pathology.

But there is another system in the economy which seems to share with the veins the unfortunate privilege of concurring in the production of a variety of disorders, and which has escaped notice hitherto; to wit, the lymphatic system. In this point of view, it may indeed be affirmed, that it has been left in the same oblivion as was the circulatory system of the black blood, before it was made the subject of investigation by J. Hunter, and the modern physiologists. Adopting, to a great extent, the ideas of Mascagni, as to its physiology, I long since devoted my attention to the study of its alterations.

I felt satisfied, as the lymphatic vessels exist throughout the entire body, and as, like the veins, they serve for the convergent circulation, that, like them also, they might transport from one place to another the germ of many diseases, and by the disturbance of their own functions, give rise to changes in the tissues adjacent to them. What was already known as regards scrofula, and infiltration, and the opinions of M. Alard on elephantiasis, gave countenance to this idea; but it was necessary to examine the question under a different aspect, by taking as a guide for observation the assistance to be obtained from anatomy and physiology. My attention has been devoted to this subject since 1818; and the various papers which I published at subsequent periods, on the alterations of the fluids, are almost as strictly related to it as to the pathology of the veins; the only difference being this—that I had not, as I mean to do now, considered it separately, or in such a manner as to exclude collateral matter. The subject, however, even now, is too novel to admit of its being treated completely, and in all its details. I shall therefore confine myself to the points on which I think I shall be able to throw some light; and on that, more especially, which relates to the inflammation of the lymphatic vessels, known under the names of *Lymphangitis*, *Lymphitis*, &c., and which I prefer designating by the term at the head of this article.

The lymphatic tissue is capable of becoming inflamed in different ways, and in various degrees, like the other tissues of the body. Here, as elsewhere, we observe inflammations to arise from direct and indirect causes, from contusions, or from solutions of continuity, either of the lymphatic vessels, or of their ganglions themselves. But this inflammation, nevertheless, at its commencement, most commonly has its source in diseases quite foreign to the organs of which we are now speaking; and it will be readily recognised, that almost all the diseases of the lymphatic system arise

in consequence of fluids, either produced or vitiated by inflammation, being introduced therein by absorption or imbibition, and carried from the periphery of the body to the centre. After establishing the etiology in accordance with this opinion, we shall examine the practical consequences to which it may lead us. I may here observe, that since the publication of my first memoir on this subject in 1836, the proofs of what I then stated have become so multiplied, that I can have no hesitation in giving the most positive character to the assertions and opinions advanced in this article.

If the inflammations affecting the canicular portion of the lymphatic system have hitherto attracted so little attention, the reason is, that being, in the majority of cases, difficult to be recognized directly, they have been either mistaken for, or confounded with, the diseases of some other system—that of the veins for example. A rapid glance at their causes, mechanism, and situation will help to show the truth of this assertion in a clearer light.

Etiology.—Without absolutely admitting, with Mascagni, Fohmann, Faust, and Panizza, that the lymphatic vessels alone constitute almost the entire bulk of the cellular tissue and its components, we are compelled to acknowledge that these canals abound in the midst of the organic layers of the animal economy; nor does any one now deny their faculty of absorption.

The inference from this simple remark is, that lymphatic vessels surround and pass through every seat of disease, and that wherever disease exists, they may become charged with heterogeneous materials calculated to inflame them. This notion which, *à priori*, is in accordance with the doctrines of anatomy and physiology, is confirmed by daily observation at the bed-side of the sick.

Even in this respect the inflammation of the lymphatic vessels presents two very distinct varieties. In the one, the seat of the morbid action, or the altered fluids that give rise to it, are protected from the contact of the air; in the other, on the contrary, they are exposed to its action, either primitively or consecutively. Hence an essential difference, which it will be important not to lose sight of.

When there is no wound, ulcer, incrustation, or excoriation on the integuments, the altered molecules, modified by inflammation, or by any other morbid action, but rarely acquire properties as deleterious as those which in general characterize them, when deposited in deep wounds or solutions of continuity; and hence the possibility of their penetrating to some extent into the veins, without exciting inflammation, or producing any manifest disturbance. The same thing is clearly observed to occur, in regard to the lymphatic vessels, which, if it were otherwise, would be affected in almost every case. It may be added that, as in the case we are supposing, they are not contused, ulcerated, or cut, but

protected, as it were, by the inflammatory action that is taking place in the other tissues, these canals are but little disposed to allow the surrounding fluids to penetrate them.

In opposite circumstances, the contrary obtains; and to be convinced of the fact, we have only to bear in mind, how rapid and numerous are the changes which take place on the surfaces of wounds in all the products of inflammation, in all the substances either taken into or ejected from the body; and that by reacting on each other, under the influence of the air, their elements are transformed, sometimes into new products, comparable in certain cases to real poisons. In becoming fluid, these substances are more in contact with the pores or extremities of divided vessels, and are thus rendered in general more acrid and penetrating. It seems but natural, therefore, that they should obtain an easier access to the torrent of the circulation, and that they should irritate the vessels more highly than in the preceding hypothesis. We may, however, imagine angeioleucitis to take place without any external breach of continuity, and by a mechanism similar to that of traumatic suppuration; all I mean to state is, that under such circumstances, *cæteris paribus*, it is of much rarer occurrence.

Angeioleucitis may be developed in three different ways: 1. *By continuity of tissue*, or from the external to the internal surface of the canal. In this case the lymphatic vessels that pass through inflamed organs at length become themselves inflamed at the point corresponding to those organs before they exhibit any trace of disease elsewhere. 2. *By obstruction*, or disturbance of their circulation. In this case they are so compressed in the midst of the diseased tissues, that they become inflamed below this point, in consequence of the distension resulting from the stoppage of their circulation; and 3. *By absorption*, or from within outwards. That is, when either, through their lateral pores, or their roots, they take up, in the affected parts, irritating principles in sufficient quantity to determine an inflammation, in the same manner as it occurs in the veins, or when the mischief has its source in a collection seated in the integuments.

In this last case, the inflammation of the lymphatics may also exist in three ways. 1. *By continuity*, or as it takes place in membranous organs; in which case, the inflammation, proceeding from the wound, attacks the lymphatic vessels, and seems to be rapidly carried towards their origin or termination, without their becoming of necessity on that account previously charged with the morbid products. 2. *By internal irritation*, or by *infection*: that is to say, that those of their mouths or roots, that are enveloped in the diseased locality, becoming charged with heterogeneous molecules, are rendered incapable of bearing the contact of such substances with impunity, and become inflamed secondarily, from the internal to the external surface in one or more points of this course. This is

unquestionably the mode in which angeioleucitis is produced in the majority of cases ; but we must admit also, that it may proceed from the external to the internal surface, or 3. By *contiguity of tissue*, as in the case where the skin is perfectly entire and healthy.

We have said enough to show how numerous and how various the causes must be that produce inflammation of the lymphatic vessels.

In taking the first species mentioned, viz. that which arises without any external solution of continuity, it will be perceived that inflammation in general, whether acute or chronic, whether diffused or circumscribed, is an incessant cause of it, so long as it exists in parenchyma, in the glands, under the skin, between the muscles, around the bones, in the joints—in a word, wherever the cellular tissue is found. It is the same with regard to the pus, whether it be found in the state of infiltration, or collection, or in that of a phlegmonous, or congestive abscess. What is said of pus applies also to blood, and to all other effused fluids, that have undergone alteration in the situations in which they happen to be pent up. All forms of cancer, tubercles, and the greater number of degenerations of tissue and of morbid productions, fall under the same category.

The second species of angeioleucitis has its source in all kinds of solutions of continuity, which, either immediately or at a distance, communicate with the atmosphere. Thus, perhaps, there is no disease of the skin that may not, at one time or another, have produced it. The psoric, lichenoid, eczematous, and variolous affections, ulcers, chilblains, scratches, wounds of all kinds, patches, or syphilitic tubercles, scirrhus, and encephaloid masses, and all forms of ulceration often give rise to it. Fistules, open abscesses, fractures, luxations accompanied with laceration of the integuments, and suppuration, the wounds resulting from amputations, or from any other operation, are equally capable of producing it. If we pass from the skin and the subjacent tissues to the mucous membranes, we shall only have to repeat these remarks, viz. : that the inflammations, eruptions, ulcerations, or lesions of whatever kind, of these tunics, that produce a morbid change in the fluids they imbibe, or with which they may be in contact, very frequently determine angeioleucitis.

After this enumeration, we cannot help being struck with the proportionate rarity of inflammation of the lymphatic vessels ; but our wonder soon ceases, when we reflect that all these various causes are in general merely predisposing, and that conditions of another kind are still required in almost all cases to convert them into occasional causes. All these causes, however, of whatever kind they be, seem to act with greater energy at puberty, and in old age, than in the adult or middle period of life ; when the cellular tissue and the white fluids are predominant, than

when the constitution is dry and nervous, or strongly muscular ; when the constitution has been exhausted by intemperance, improper regimen, or protracted illness, than when the health is good, and the individual robust. But, besides, the altered molecules must either penetrate in sufficient quantity, or be endowed with certain qualities to produce effect. In some cases, there may be absorption to a considerable extent, without producing any manifest bad consequences, whilst, in many others, a few molecules will be sufficient to determine the most intense and extensive inflammation. This peculiarity helps to explain why angeioleucitis is so uncommon, when compared with the frequency of the causes capable of producing it, in the inflammations or other affections not exposed to the action of the air, whilst the slightest puncture or abrasion, the most simple ulceration of the integuments may quickly produce it. It will also be easily understood how certain relative positions of the orifices of the pores of the lymphatics, as regards deleterious principles, should favour in a particular manner their absorption ; vivid moral impressions, a sudden disorder of the functions, in a word, any circumstance capable of subverting for a moment the vital or organic harmony, in parts beyond that which had been primitively attacked, are equally calculated to develop its defects. In some cases, it might be said, that the causes of angeioleucitis, watching as it were for the moment when the organism is engaged in a struggle against danger from another source, assail the venous or lymphatic systems with the unresisted force of chemical action.

When the development of a disease may be promoted or retarded by so many conditions, it cannot be matter of surprise, that its natural causes should be so frequently present without producing it.

We may also add, that the molecular movements which commonly bring on angeioleucitis are probably subject to many other influences, and that we cannot at present presume to assert that we are in possession of all the bearings of the problem that relates to this form of inflammation.

Symptoms.—The phenomena accompanying inflammation of the lymphatic vessels are twofold, viz. : local and general. The local symptoms themselves differ more or less, according as the inflammation is superficial or deep-seated ; it will be proper therefore to examine them in succession under these different aspects.

When the disease arises in the subcutaneous lymphatic vessels, if we examine carefully, we shall find, *almost always*, the cause to be a solution of continuity, an inflammation, or suppuration of the skin. A change is observed to take place in the pre-existing lesion ; the diseased surface seems sunken and more inflamed ; swelling takes place, and pain is felt around the wound ; the suppuration which was going on in it is suddenly dried up or altered in quality, or it may all at once be-

come more extensive ; an erythematous blush appears round those wounds or ulcers that had been dressed with deteriorated adhesive plaster or rancid applications, or which had been covered with incrustations ; streaks, bands, or patches, varying in colour from a bright or rosy red to a wine or violet hue, soon appear at other points of the diseased region. These bands are tortuous, irregular, and cross each other in such a manner as to form small islets of sound skin, and follow the tracks of the lymphatic vessels. They do not show themselves first on the parts nearest to the wound ; those first seen are even sometimes at some distance above it. Erysipelatous patches, similar in colour, soon show themselves over a certain extent of the affected region. At first, they appear disseminated over different points, but they gradually group together, and are confounded into a species of erysipelas. The parts surrounding the centre of the disease are, in general, the first affected ; from these it spreads in the same manner as common inflammation ; but most commonly it shows itself at other points, more or less, so as to appear as if the patient had been attacked by erysipelas at several places simultaneously, each of these points being united with the rest by red lines or streaks. An acrid burning pain is felt in the situations of these red patches, and it even sometimes precedes the appearance of these red streaks or bands ; it is exasperated by the slightest touch, and has the same character as the pain accompanying erysipelas—it is not throbbing, stinging, or lancinating, but resembles more closely that which is felt in a part that has been sun-burnt ; the swelling is slight at first, and scarcely perceptible between the inflammatory streaks, or even along their course. These bands themselves sometimes retain all their natural suppleness, and by no means communicate that feeling of induration which, from their appearance, one might be led to expect. The patches also may exist for some time without presenting this complication ; the contrary, however, is most frequently observed, and the tumefaction of the subcutaneous layer follows quickly upon the development, of those inflammatory trains or patches. The diffusion of the swelling is but seldom complete ; it extends very irregularly both in depth and surface, and is developed more perhaps by nuclei than by patches ; the rarefaction that it produces seems moreover to be manifested more in the skin, cellular tissue, and the neighbouring layers, *en masse*, than to confine itself to any one of them in particular. It appears to attach itself much more closely to the canals, plexuses, and lymphatic ganglions, than to the anatomical arrangement of the cellular tissue, strictly so called. At first, the tissues retain a certain degree of suppleness, notwithstanding the swelling and redness. At a later period, the tension increases, and their feel is like that of sponge ; to the finger they seem as if they were œdematous, and are in reality the seat

of infiltration ; the tension, however, has not a frank, elastic, equal, and regular character, nor is it the same as we find in the doughyness of the acute phlegmon, or phlegmonous erysipelas. What has been stated as regards the redness, swelling, and tension, will apply also to the heat, which is great only at the commencement, and which does not increase in proportion to the other symptoms. To render the description of superficial angeioleucitis complete, we have only to mention the swelling of the ganglions, into which the inflamed vessels pass as one of its most constant symptoms. It is difficult for the fluids circulating in a canal thus affected, not to deposit some germ of irritation in the ganglions through which they pass. It is, however, possible to conceive such a case, and I have myself seen several instances of it, either in consequence of obstruction below the seat of the disease, or from its being rapidly circumscribed, and the vessels becoming obliterated, so as quickly to transform it into an erysipelas or phlegmon.

When the attack occurs first in the deep-seated lymphatic vessels, as sometimes happens in the case of wounds or ulcers that pass under the fasciæ, as also of contusion, inflammation, abscess, or ulcer, the symptoms assume a somewhat different character. It is the pain that first attracts notice. It is fixed in a particular spot, where it may remain for a considerable time ; it is deep-seated, sharp, or lancinating. If the mischief extends, the pain is soon felt in other regions, simultaneously or successively ; and though it cannot be said to be positively absent in the intervals separating the points in which it is most acutely felt, still it does not excite sufficient uneasiness to be much complained of. The pain is not radiated in lines from a given point, nor is it diffused, neither does it remit ; it is a fixed pain, though disseminated over particular spots, varying in the degrees of its intensity at different points. The tumefaction comes on afterwards, or it may occur almost at the same time, and in the same places as the pain. It proceeds, and is developed from the centre to the circumference. It is observed under the form of masses of more or less extent, of thick and long cores ; but there is no appearance of patches, as in the case described already. Its origin is without difficulty recognized to be from beneath the fascia, and the tissues are less dense in proportion as they are nearer to the skin which retains for a long time suppleness and a certain degree of mobility. Should the swelling become general, the first characters will nevertheless persist to some extent to the end ; in the midst of the general tumefaction we can discover, here and there, points more swollen and perceptibly more dense than others. The redness only becomes manifest subsequently to the two preceding phenomena. It is less superficial than in the former variety, and can be only seen as it were by transparency in the shape of irregu-

lar patches, and not as streaks or bands. It would seem to be more intense and more extensive according as the eye pursues it to a greater depth. The skin moreover being stretched, and as it were thinned, is shining, and more of a whitish or pale rose colour, than truly red, in the intervals of the inflamed points. Generally speaking, it is the deep lymphatic ganglions that first swell and become painful. The inflammation proceeds so rapidly, and to such an extent, that the deep-seated variety of angeioleucitis has, in many cases more the appearance of inflammatory œdema, than that of a diffused phlegmon or of a phlegmonous erysipelas.

It would, however, be wrong to imagine that the two plans of the lymphatics may be thus long affected independently of each other. More frequently, on the contrary, the affection of the superficial lymphatics is communicated to the deep-seated vessels, and *vice versâ*. Hence in the first variety the engorgement, infiltration, and pain, are often found to extend to the entire thickness of the parts, in the same manner as in the second; sooner or later, red streaks, and true erysipelatous patches are seen on the skin; and thus do the superficial and the deep-seated ganglions become almost invariably affected in both cases.

There is, however, no difficulty in explaining this progress of the inflammation of the lymphatics. The ganglions swell because vitiated materials are presented to them instead of the fluids which usually pass through them. The bands and red streaks only show that the inflammation has been transferred to the cellular envelope of each of the inflamed vessels; and it is only at the points where these vessels inosculate, or seem to form a net-work, that those patches of deeper red, and those kernels of greater hardness, can be discovered, because at these points, several inflamed lines may, at an early period, have been confounded, and extended from one to another, through the medium of the interposed cellular tissue. The tumefaction and engorgement, in this instance, as in every other inflammation, are attributable to the afflux and stagnation of the different fluids; but they are more considerable, and more frequently accompanied by infiltration, because the lymphatic vessels cannot be, for any considerable time, inflamed, without having their calibre diminished, the course of the lymph deranged, or without causing a portion of the white fluids to be extravasated into the surrounding tissues, and thus to stagnate, in consequence of being forced out of their natural channels. The disease passes from one plan of the lymphatic vessels to the other, in consequence of the numerous communications that exist between them, and because, by the disturbance of the functions of the one the disease almost necessarily reacts on the other. It may be also added, that angeioleucitis must frequently be followed by erysipelas or phlegmon in various shades, either on account of the stagnation of the fluids it produces in

the surrounding tissues, thus giving rise to inflammation on the confines of the parts occupied by the disease, or because those fluids which it prevents from returning into the general circulation soon act as foreign bodies between the small canals that had been primitively affected.

General symptoms.—These not being subject to the same modifications as the local symptoms, it becomes unnecessary to make a distinction in this respect between the superficial and deep-seated angeioleucitis. Its invasion is often announced by mere horripilation; but more frequently it is ushered in, or preceded by, irregular rigors, or ague-fits, like those of vernal intermittent fever, or the trembling or agitation that indicates the extensive inflammation of a serous membrane. These rigors, or tremblings, alternate with great heat and dryness of the skin, the rosy hue of which rather increases, than diminishes, at least during the first days of the attack. The pulse, always frequent, is at one time strong and full, as in an inflammatory fever; at another, small and irregular, as in low fever. There is in general great thirst, and a feeling of anxiety about the præcordia; the patient suffers from nausea, and sometimes from vomiting. Complete delirium is seldom manifested at first, but watchfulness and agitation are almost always present, accompanied by manifest alteration in the functions of the nervous system; the mind seems absorbed in reveries; the ideas are confused. A part, or even the whole of these various symptoms may be present two or three days before the local symptoms become developed.

The accompanying fever has nearly the same character as that of an exanthematous inflammation; with this difference, however, that instead of disappearing, it becomes aggravated after the development of the angeioleucitis. The tongue is covered with a greyish or yellow fur; it is soft, and but slightly reddened at its point or edges; it does not become dry till a more advanced period, unless the disease be very intense. When this is the case, the point and centre are the first to become incrustated. In some cases, however, it assumes the appearance of a rasp throughout its entire surface. In being dried up, it does not always lose its greyish or red colour; the tissue of the tongue itself seems to be hardened, just as much as the slimy crust with which it may be covered. At a later period it is entirely covered with crusts, and is cracked in the same manner as in typhus fever. The gums and the rest of the mouth become fuliginous, and most commonly delirium supervenes. On the whole, angeioleucitis gives rise to a degree of general reaction, which resembles more closely an ataxic fever, than one of a purely adynamic character.

We can easily account for the disorders we have been describing by arranging the symptoms into two distinct groups: the one produced by inflammation,—the other, result-

ing from the infection of the blood. The development, fulness, and frequency of the pulse, the heat and high colour of the skin, and the thirst, belong to the first; the rigors, agitation, nausea, and the state of the mouth, to the second. When the inflammation runs high, and is extensive, the vascular reaction is at first very considerable. The ganglions, and the obliterated vessels impede, it is true, the admission of pus, or of an irritating principle into the blood, but do not absolutely prevent it in all cases. So long as the circulation in the lymphatics is carried on, it is almost impossible that some portion of the fluids vitiated by the angeioleucitis shall not find way into the veins; and I am only astonished that the fact could be disputed. It cannot, however, be denied, that this infection takes place very slowly, and, as it were, by molecules; and hence it is, that the symptoms which indicate it are, at first, in a manner lost, or confounded in the midst of the symptoms of inflammatory reaction; whilst, at a later period, they often become predominant.

Termination and prognostic.—The inflammation of the lymphatic vessels may terminate in resolution; but suppuration is one of its very common consequences; it also terminates often in death. Resolution may be confidently looked for when the inflammation extends to but a few vessels, and when it has not gone beyond the superficial plan. The same may be said of the cases in which the parts where the inflammation has become developed are of a nature to cause its prompt subsidence, or to admit of its being easily accessible to the resources of art. When the circumstances are different, suppuration is almost inevitable; it must be expected to supervene whenever the red patches are numerous, and have a tendency to run into each other, and when beneath them, painful cores of a certain thickness can be felt. The suppuration, however, takes place slowly, and is found in two different states, either in that of infiltration, or as a collection of variable extent. The pus remains infiltrated under the red streaks, along the vessels, and between the layers of muscles. The abscesses occur more particularly under the patches, and in such a manner that the principal inflamed nuclei form the centres of so many purulent collections. Sometimes, also, the abscess is large, and the matter is diffused as in the case of a phlegmonous erysipelas. But whether these abscesses be superficial or deep-seated, the fluctuation is not felt in them till an advanced period, and when opened, the quantity of pus which escapes is much more considerable than could have been expected from the apparent extent of the tumefaction. There is generally more than one, and the first collection is merely the precursor of several others, which occur in succession, at intervals of a few days, and at different points. I have in this way seen as many as twenty-five in the same individual. They are surrounded

by a pasty, or hardened edge; but it does not remain so long as in the case of a common phlegmonous abscess. In the cavity, neither bands nor partitions can be detected, and although the pus contained is usually very fluent and thin, the secretion soon ceases, and the parts cicatrize rapidly.

The termination by induration without suppuration is rather uncommon, and occurs almost exclusively in chronic angeioleucitis. M. Alard's description of it is tolerably correct. Some cases of this form of the disease have been since published by physicians who have devoted their attention in a special manner to the diseases of the skin. It occurs after the acute form of the disease, only accidentally, as for instance when some constitutional taint, or an imperfect treatment may have disturbed the progress of the symptoms. In this case, the lymph which remains in the state of infiltration in the meshes of the cellular tissue is but slightly altered, and sufficiently concrescible to have a constant tendency to combine with the tissues which it has swollen, or hypertrophied, and which it transforms into lardaceous layers or masses.

Angeioleucitis may terminate in death, either at the time when the inflammatory reaction is at its height, or towards the end, when the suppuration is prolonged. It may be apprehended, in the first case, when high delirium, a dry mouth, and nausea accompany an extensive inflammation, which continues unabated till the eighth or tenth day. It may also be dreaded in the case where the inflammation is extensive, deep, and severe, more especially in an individual of broken constitution, or advanced age, and when the suppuration threatens from the first to be vast and abundant. At a later period, the fatal termination is brought on by the recurrence of the abscesses, through the exhaustion arising from the abundance of the purulent secretion, from the occurrence of fresh attacks of the disease in the viscera, or from effusion into the serous cavities, and vitiation of the blood, by its mixture with the pus, or absorbed substances. Rigors, with decomposition of the features, intermittent fever, diarrhoea, irregular sweats, meteorization of the abdomen, pain or uneasiness in the head or chest, are the usual preludes to it.

On the whole, the progress and duration of angeioleucitis are extremely variable; in some instances, it is developed so rapidly that on the eighth day there can be no longer a doubt as to the formation of pus; in others, the progress is so slow, that even on the twentieth day, there is no saying with certainty how it will terminate. In some individuals its phases are perfectly regular from beginning to end, whilst in others, all the groups of symptoms are graduated and distributed as if they belonged to several distinct and successive inflammations. When resolution takes place, it may be looked for from the fourth to the tenth day. The suppuration may be established as early as the eighth day,

but most commonly it does not become manifest until the fifteenth or twentieth. It is also from the eighth to the twentieth day, that death is observed to take place. Beyond this period it seldom occurs till after the thirtieth or fortieth day, when induration may take place, and when internal collections, the contamination of the blood, and diarrhœa, are more especially to be feared.

These details, which I have taken from the attentive observation of a great number of cases, show clearly that angeioleucitis is a disease of sufficient gravity to excite the deepest solicitude on the part of the practitioner. The dangers to which it exposes vary, however, according to an infinity of circumstances, relative to the importance of the part affected, to its superficiality or depth, to the nature of the morbid principle which has produced the disease, and to the peculiar disposition of each patient. It must be obvious, all other conditions being alike, that the disease must be more serious when situated in the splanchnic cavities, than on the surface of the body; that it must be less dangerous when confined to the integuments, than when it extends through the entire thickness of a limb; the presence of a wound must also render it more formidable. When the disease is caused by the absorption of a septic principle, as for instance, in a dissecting wound, it is most dangerous. In other respects, the more serious the lesion from which it arises, the greater will be the danger; whenever it originates from a deep compound fracture, an articulation that has been opened, or a purulent cavity situated in the midst of tendons, &c., it always puts the life of the patient in more or less jeopardy; whilst the form of the disease which occurs in connexion with a solution of continuity of the integuments, or of the subcutaneous tissue is generally more disposed to terminate favourably. It may be observed, therefore, that the angeioleucitis that arises in the intestines in the course of typhus fever, in the bronchi from measles, in the uterus from metro-peritonitis is infinitely more formidable than that which takes place after the application of leeches, or the small wounds inflicted in cupping. In infancy, it is more prone to terminate in induration than in death. In the adult, its most common termination is in suppuration. In persons debilitated by illness, or of advanced age, the consequences most to be dreaded, and which render the disease so very serious, are low fever, gangrene, &c. We may also add, that its dangers depend, moreover, on the circumstances that may complicate the primitive affection, and that, in consequence, nothing can be more difficult, than to generalize the prognostic of angeioleucitis.

Differential diagnostic.—We may observe once more, if the inflammation of the lymphatic vessels has been so much overlooked hitherto, the reason is simply this: that some of its symptoms have a close resemblance to those of several other affections; such, for

instance, as phlebitis, neuritis, or neuralgia, erysipelas, and phlegmon. However, as it differs in a great many respects from these lesions, a clear examination of its principal symptoms ought to enable us to avoid such mistakes. It is the more important to establish a differential diagnostic, as, in regard to the prognostic and treatment, there can be scarcely any analogy established between it, and the other forms of inflammation that so closely resemble it; and, as it can only be by proceeding in this manner, that the confusion which still prevails in the therapeutics of the inflammations of an acute character, can be dispelled. In this point of view, therefore, it is of especial importance to contrast it with phlebitis and erysipelas.

Phlebitis, it is true, is produced by the same causes, and under the same influences as angeioleucitis, but its progress and anatomical characters are far from being in every respect similar. It is most commonly ushered in by purely local symptoms, instead of commencing by a movement of general reaction. The red bands which indicate it are larger, fewer, less frequently crossed, more deeply seated, and correspond to so many hard, round, moveable cords, which are painful, and sometimes as thick as the finger. The red patches, when any exist, rest on nuclei that are more clearly defined, less deep, and less adherent; and they seldom become united in such a manner as to constitute a tolerably regular erysipelas. The suppuration occurs more rapidly, and the abscesses thus formed are either diffused, as in phlegmonous erysipelas, or less full of matter than might be supposed before they were opened. The pus evacuated from them in the latter case is often reddish, and seems as if it were mixed with decomposed blood. They are sometimes very numerous, but smaller; and they are almost always developed along the tracks of the large venous trunks, but not dispersed indifferently throughout the different regions of a limb. The tumefaction is, in general, less, and does not extend to the entire thickness, or to the whole circumference of the part, unless the phlebitis be deep-seated, and in that case, the redness of the skin, and the subcutaneous abscesses have no resemblance whatever to those produced by angeioleucitis. The skin is neither tense nor shining; it seems rather thickened, or simply inflamed. If infiltration be added to the inflammatory engorgement, it remains, almost constantly, below that degree of it which might cause it to be mistaken for œdema; it seems to be rather under the skin, and to possess that character of doughiness which indicates in the diffused phlegmon the presence of pus. As soon as they are opened, the abscesses of phlebitis empty themselves, and resolution takes place rapidly without leaving any permanent traces of induration beneath them. *In general*, the lymphatic ganglions are neither swollen nor painful, and the pain, instead of being severe, is dull.

The general symptoms have less of the inflammatory than of the adynamic character, and do not begin to be manifested till the time when the pus, secreted and exhaled by the veins, commences to circulate with the blood. Their development is then rapid. The rigors and tremblings are longer and stronger, although more irregular; the pulse is smaller and more unequal; the tongue is more foul, and more frequently red, and then dark, before it becomes dry and incrustated. The agitation, anxiety, heat, and thirst are less; the delirium, and irregular sweats come on more quickly. An expression of stupor is soon observed in the countenance; there is diarrhœa or constipation; the skin, which is of a grey or leaden hue during the cold stage, often assumes a gradually deepening yellow in the intervals of the rigors and tremblings. The resolution is more easily accomplished either before or after the suppuration becomes established, so long as the symptoms of purulent infection are not manifested. On the other hand, death almost always ensues, when the general symptoms are developed. The patient dies, or is out of danger, except in the case where the progress of the inflammation is irregular, much sooner than in the angeioleucitis. Phlebitis, in a word, is formidable, more particularly from the kind of poisoning it causes, and by the facility it finds of extending itself towards the great vascular trunks; while angeioleucitis is infinitely more so, on account of the local disorders of a decidedly inflammatory nature that result from it. As a local inflammation, the former is very easy, the latter very difficult to check. As a general affection, the case will be exactly the reverse of this. Leeches, not general bleeding, will often arrest a partial phlebitis; compression, multiplied incisions, mercurial ointment, or flying blisters, will have the same effect. If suppuration takes place, and that the pus is not poured into the torrent of the circulation, the development of the general symptoms will be prevented by the opening of the abscesses; and though the disease may have been very extensive, it will be by no means serious. When the signs of infection exist, the local treatment is of no value whatever, and even the internal medication, whatever it may be, is of very doubtful efficacy.

We see then, that if some points of resemblance exist between angeioleucitis and phlebitis, the points of dissimilarity are still more numerous. After the parallel just drawn, it would be no longer pardonable to confound them one with the other, except in the case of which it is easy to conceive the possibility, and I have myself witnessed more than once where the one was added as a complication to the other. The inflammation of a large vein, it is obvious, may be transmitted from it to the numerous lymphatic ganglions which surround it. In this case, the ganglions will become engorged, unquestionably, as in angeioleucitis, and the infection of the blood will be effected as in phlebitis, but the very fact

of these two classes of symptoms being observed to be present together, will be sufficient to apprise the practitioner that these two diseases are united. The same thing would take place, but in an inverse sense, if the inflammation was transmitted from the veins to the lymphatic vessels. The succession of the symptoms, or the order of their apparition, would moreover indicate which was the primitive affection, and which the complication. It must, however, be admitted that these two forms of inflammation exhibit a very close affinity in regard to their causes, their mode of production, and their deadliness. It would, therefore, be improper to attempt to isolate them by means of perfectly defined signs and limits. Their tendency to unite, both at the commencement, as well as through their intercourse, the symptoms that are common to both, and the difference as regards the dangers incident to them, are quite enough to challenge all the attention that the practitioner can bestow on the distinctive characters of these two diseases.

The symptoms of angeioleucitis could only have been mistaken for those of nevritis through inadvertence or the little attention bestowed upon it, as a distinct form of inflammation. Whether there be true nevritis, or mere neuralgia, the affection will be nevertheless manifested by pains, which are at once radiating, dull, and lancinating,—pains which are not always augmented by pressure, which are liable to frequent exacerbation, and which follow, from the trunk to the branches, the known course of one or more nervous cords; by the weakness or numbness of the part; by the absence of tumefaction, redness, streaks, erysipelatous patches, external suppuration, infiltration, and of all the other symptoms of phlebitis and angeioleucitis.

Erysipelas.—The mistake, though more likely to be made in regard to erysipelas and phlegmon than nevritis, is not so much so in regard to phlebitis. If we examine the question attentively, we shall be readily convinced that angeioleucitis is more frequently mistaken for erysipelas than for any other affection, and the reason is this,—that many surgeons continue to comprehend under the name of erysipelas many very different diseases, many forms of inflammation that are by no means identical. If a diffuse inflammation of the integuments were alone sufficient to constitute an erysipelas, there can be no doubt that angeioleucitis, and even phlebitis, might in many instances be thus designated. But it is quite obvious that this mode of considering the matter is inadmissible; else how can there be any agreement respecting the value of the therapeutic agents to be employed, or how can any opinion be formed as to the danger of the disease? We must conclude, therefore, that it is of the utmost importance to distinguish these two forms of inflammation from each other. Common erysipelas is neither preceded nor accompanied by red streaks, or tumefaction of the lymphatic gan-

glions. If the contrary should take place, it only so happens in consequence of the erysipelas being complicated with adenitis, or angeioleucitis. The inflammation in this case seems to proceed from the epiderm towards the deep-seated layers of the skin, and is not manifested in scattered patches. The subacute swelling is equal, and simply subcutaneous, being neither deep-seated nor distributed in masses or cores. It extends by continuity of tissue, instead of bounding, as it were, from point to point, over different regions. The skin, and not the layer beneath it, is its primitive and specific seat. Its progress is much more rapid: the formidable symptoms, such as delirium, and dryness of the tongue, often appearing as early as the fourth or fifth day. It rarely terminates in suppuration or induration, and resolution takes place from the third to the eighth day. When death occurs, it can scarcely ever be attributed to the local mischief. Topical applications have little, if any influence in arresting its course; neither leeches, nor compression have any effect; and the same may be said of poultices, emollient fomentations, and mercurial inunction. Those who attribute great virtue to mercury are altogether in error, as the pure axunge alone is just as efficacious, and it can only have been through an imperfect observation of the facts, that the error could have obtained credit. All these applications, together with blisters, which, on the contrary, will be found useful at a certain stage of angeioleucitis, are in this form of inflammation quite useless. In erysipelas, the surface of the epiderm seems as if thickened, and presents small vesicles, and sometimes even phlyctenæ of a certain size. It has a yellowish rosy hue, terminating abruptly at the limits of the disease, by an elevated and festooned edge; half a line beyond which, the slightest alteration of colour in either the skin or epiderm cannot be discerned, and it would seem as if the inflammation was shed over the derm like a layer of milk or oil. We see nothing of this kind in angeioleucitis,—the redness of which is bright or pale, or inclined to violet; it has no defined limit, but disappears insensibly, in such a manner, that it would be impossible to fix the line that separates the disease from the unaffected tissues. The skin may be thickened and elevated, but in general it is not covered, either with vesicles or phlyctenes at the commencement; nor does it present a surface in relief, as if it had been overlaid with another layer.

If we now pass from simple erysipelas to the *phlegmonous erysipelas*, differences less strongly marked, it is true, but still sufficiently obvious, will be quickly discovered. At the outset, most commonly, the general symptoms are absent; the inflammation spreads gradually, leaving none of the parts unattacked through which it passes. It does not appear under the form of scattered patches, or indurated cores; neither is there any appearance of red or livid bands. The ganglions are not

engorged, nor does it seem to be developed more along the trunks of the lymphatics, than elsewhere, although, like angeioleucitis, it appears to spread rather from the deep-seated tissues towards the surface, than from the epiderm towards the fasciæ. Suppuration takes place very rapidly, the collection being large and widely diffused, and the pus greyish and thin. The cellular tissue is extensively destroyed, and the integuments are so rapidly thinned as to be in danger of perishing also. If the inflammation has not attacked from the beginning a considerable extent of surface, the febrile reaction will be, in general, trifling before the pus is formed.

The general symptoms are not of a nature to excite any serious alarm, till after the second period. We then have symptoms of infection, but which tend rather to the adynamic than to the ataxic character. The skin becomes dull, soiled, and earthy; the tongue blackens, and the delirium is of a calmer kind. If the attack be recent, and still limited to a small space, general bleeding, and emollients, properly employed, will often bring on resolution. The application of cold water will also stop it during the first two or three days. Compression, properly made, is regarded as the grand remedy, so long as suppuration has not taken place. Mercurial inunction will not arrest its progress. When we cannot insist on compression, multiplied incisions stop it at once; as if by enchantment. Blisters do not abridge its duration, unless they be of enormous size, and are only calculated to assist in circumscribing certain purulent collections. We see, then, that phlegmonous erysipelas is a disease essentially distinct from angeioleucitis. It must, above all, be not forgotten, that the one often complicates the other; and it is for this reason that they have been, and are still, daily confounded in practice. A most remarkable instance of this occurred in my own wards, in the months of March, April, and May, 1837: almost all the patients that had been affected with angeioleucitis were soon after attacked with erysipelas, strictly so called, or with phlegmonous erysipelas; and, in like manner, those who were first attacked with erysipelas, soon presented it complicated with angeioleucitis. But these combinations by no means prevent our singling out the special characters and symptoms that belong to each of these diseases, and that distinguish them from the compound inflammation.

As to the common phlegmon, its aspect is so well defined, that if we only examine with a little attention we cannot be deceived. Its circumscribed form, its hardness at the very beginning, the throbbing pain, and heat, the elevation which it tends to present towards the skin, the simplicity and regularity of its progress, the absence of streaks, of scattered patches, of engorged and painful ganglions distinguish it so clearly from angeioleucitis that there is no room for mistake in this respect.

The *Erythema nodosum* is a disease, which, to a certain extent, might impose on the practitioner. In some cases, this affection, which is characterized by the sudden development of a variable, sometimes a considerable number of red or livid patches spread here and there over different parts of a limb, is preceded by fever for two or three days, and so far really does present some analogy to angeioleucitis. Happily, the dark hue of those patches, and their superficial position, the appearance of fluctuation which they present, and their sudden disappearance after a few days, without leaving any trace behind, in conjunction with the absence of general symptoms, and of engorgement of the ganglions after they have been once developed, will not leave us long in doubt as to their true nature. With one moment's reflection, indeed, the error would be scarcely possible.

Pathological Anatomy.—The alterations that follow inflammation of the lymphatic vessels, are of three kinds: the first is of the vessels themselves; the second takes place in the interposed tissues; the third must be sought for in the viscera, in the blood, and in the remote regions.

In consequence of their minuteness, the lymphatic vessels, even after they have been inflamed, are not always easy to be examined in the dead subject. When they can be successfully isolated their internal surface is found to be slightly tomentous, and rather of a milk-white than a rosy colour; on the outside, they are surrounded with cellular tissue, which is easily broken down, and more or less infiltrated with a turbid, half concrete lymph; their parietes are evidently thickened. I have several times ascertained that even under these circumstances, their permeability may be maintained. The points most diseased are those which correspond to their crossings, and those opposite to their valves; it is at these points that their envelope is often found infiltrated with true pus, that they are closed, that lardaceous cores are observed, the same as in the centre of an abortive phlegmon, and that we must look for the origin of some of those abscesses, that have been observed during the progress of the disease. The skin, which is sometimes covered with large phlyctenes, presents towards the end scattered eschars, or mortified patches. These patches are greyish, or of a yellow white; they are softened, puffed, and in a state of purulent decomposition, or rather of gangrene,—their aspect bearing some analogy to the soft tenacious centre of the furuncle or anthrax. Beneath the integuments, the cellular tissue is found to possess a healthy character in some places; in others, it is more or less indurated, and, as it were, lardaceous, infiltrated with pus or turbid serum, broken up by ulceration wherever purulent collections have taken place, and more or less thickened throughout. The fasciæ, muscles, and nervous cords are but little altered, the disorders being confined chiefly to the interstitial cellu-

lar tissue. Between the muscles, around the vessels, in a word, wherever this tissue exists, it is infiltrated, hardened, thickened, or destroyed, from space to space, in the same manner as we observe under the skin. When there is suppuration, the matter is found in circumscribed collections, rather than in sinuses, or canals; and, unless in a very rare case, no mortified tissue can be discovered beneath the fascia. The arteries and veins are sometimes thickened or increased in size: but in dissecting them, this appearance is found to depend on the thickening of their external layers, and on their vicinity to the larger lymphatic vessels.

If the disease has existed for any time, the blood is in general very fluent, abounding in serum of a reddish rather than a dark colour. The few coagula which are found in the nervous system are diffuent, and frequently mixed with yellow grains. When polypiform concretions are found in the arterial system they are also more pliable than those met within persons who die of diseases purely inflammatory; they are also less homogeneous, and they frequently present yellow, black, white, and red fasciculi. Pus, however, has not been found either in the ventricles or the great vascular trunks.

Abscesses are but very rarely discovered in the parenchymatous organs, and those which are found in the liver and lungs are more numerous than large. When angeioleucitis has had its source in a cancerous affection we find instead of them, concrete masses; sero-purulent effusion in the pleura, in the peritoneum, in the articulations, partial inflammation of the viscera, with hepatization and infiltration of pus, are also frequently observed. The brain seldom exhibits any appearance of lesion; and in the stomach and intestines the traces of inflammation are extremely faint. The follicles and agglomerate patches of Peyer are neither enlarged nor ulcerated; and if any ulceration is perceptible, it is found rather in the neighbourhood of the large intestines and the rectum. On the whole, the internal lesions found after death are often very disproportionate to the symptoms observed during life. The same remark is not wholly inapplicable to the local lesions; for we often find that the traces of inflammation are slight where the angeioleucitis had appeared to be severe. The lesions found after death, when caused by phlegmonous erysipelas, are much more profound.

Treatment.—All the plans of treatment adopted in phlebitis, erysipelas, and diffused phlegmon have been resorted to in inflammation of the lymphatic vessels; in the first place, because these affections have been mistaken for each other; secondly, because as an inflammation it would seem to indicate the use of the usual antiphlogistic and debilitating remedies; and, finally, because as it frequently disappears spontaneously, thus offering an instance of an inflammation, the gravity of which presents innumerable shades, the prac-

itioner is easily imposed upon on the score of the efficacy of the means employed. It has been treated, therefore, variously by abstractions of blood, emollients, blisters, multiplied incisions, mercurial, or ioduretted frictions, compression, purgatives, &c. Experience, however, has convinced me that these different resources may be all, either useful or insufficient; and that, in order to determine the value of each of them in particular, we must first learn to distinguish angeioleucitis from every other form of inflammation.

1°. General bleeding, which is proper in the commencement when the patient is young and robust, and there is fever present, is useless when the reaction is slight; and generally hurtful, when the period of suppuration has arrived, and at all times in the majority of aged persons, or of those whose constitutions are worn out. Leeches applied in considerable numbers over the sites of the inflammation, are either useful or hurtful under similar circumstances. When applied towards the root of a limb, in the vicinity of the engorged ganglions, they will be often found sufficient, for this simple reason, that rest, regimen, and simple external applications will cure angeioleucitis in a vast number of cases, and when attacked in the first stage.

2°. Emollient poultices applied over the solutions of continuity, and compresses of the same kind over the erysipelatous streaks, which are the only proper topical applications, while the patient is kept to the antiphlogistic plan, are of themselves but of little value when the disease is deep and extensive. Purgatives, in the beginning, aggravate the mischief; they are useful only in the subsequent stages, and then merely as accessory means.

3°. I have tried blisters: when employed in the usual way, they are altogether incapable of extinguishing or stopping the inflammation. Their action, when applied over the prominent points of the indurated masses, is limited to the hastening, or determining the suppuration or the resolution, which till then seemed uncertain. When, on the other hand, I have employed them to an extent that would really seem monstrous, the effects produced have been almost miraculous. I am not afraid, for example, to envelope the whole limb, from the shoulder to the fingers, or from the groin to the knee, and from the knee to the toes. The general and local symptoms are, by this treatment, arrested so rapidly, that in a week or two, a resolution which could scarcely have been expected, is effected. This plan of treatment may justly be considered as heroic.

4°. It will serve no good purpose to riddle the part with long and deep incisions before suppuration is established. As soon however as the matter can be ascertained to exist, issue must be freely given to it at once: the object now is to get rid of the secreted matter, and not, as in phlegmonous erysipelas to prevent suppuration. Frictions with iodine are proper only towards the end, and where induration is most to be dreaded.

5°. When the pain is very intense, lotions containing laudanum, or any other narcotic ingredient may be of use to palliate; but they possess in reality no curative virtue.

6°. As yet, I have employed *cold water* only in two cases. The inflamed part was covered with compresses, which were maintained by a bandage for two days. They were kept continually wet with water at the ordinary temperature, in the same way as I have been long in the habit of treating various wounds; but the pain and swelling increased to such a degree, that I was compelled to give up its use. A little reflection will suffice to convince us that an inflammation which occupies so many distinct points, and which is scattered in patches, filaments, and cores, situated at various depths, can but very rarely be checked by topical refrigerants. We have therefore to examine the effects of compression and mercurial inunctions.

7°. If the angeioleucitis be superficial, and extend more in surface than depth, compression properly applied may effect a resolution in a few days, when it is possible to make the pressure over all the affected points, and provided no suppuration has yet taken place. Under different circumstances, it will in general prove useless, and possibly aggravate the mischief.

But there can be no doubt of its efficacy, on the other hand when the purulent collections have been opened, and the tumefaction and inflammatory doughyness begin to assume some of the characters of oedema.

8°. While I was endeavouring to reconcile results so contradictory as those which different practitioners have said they had obtained by *mercurial inunction* in the treatment of erysipelas, it struck me, that my object would be realized by supposing that this mode of treatment, which is really valuable when applied to inflammation of the lymphatics, might be wholly useless in the inflammations of the skin and cellular tissue, strictly so called. On this point, the presumption has hitherto been but imperfectly sustained by facts. The tumefaction of the ganglions, the red streaks, and bands of the skin, and the pain of the part have constantly diminished from the first day, under the influence of the mercurial ointment. The same thing was remarked, as regarded the general tumefaction, and the other phenomena of inflammation, in three patients in whom the resolution appeared to have been produced by the remedy; but in twelve other cases, the suppuration took place in the same manner as it occurs under the other modes of treatment which are so much extolled. Possibly, however, I might have the right to conclude, from the trials I have made of it, that mercurial inunction acts as a powerful discutient on the inflamed lymphatic vessels and ganglions, although it will have but little effect against the concomitant inflammation of the interposed tissues. I must acknowledge, however, that we must still refer to experience on this point. I can, however, say

with certainty that the mercurial ointment has no other effect than that of soiling the linen in simple erysipelas, and that its efficacy in angeioleucitis is very doubtful.

I subjoin the plan of treatment which has appeared to me to be the most successful. If any wound exist, whether it be recent or of long standing, it is covered with a thick poultice: if there be any arterial reaction, recourse is had to general bleeding; the quantity abstracted to be somewhat considerable; to be followed up by the use of a tepid bath for an hour; twenty or thirty leeches are applied round the wound, when it appears red and swollen. After these means, compression with a roller will be of use; its action will be promoted by wetting it several times during the day with some resolvent fluid. Cold water perhaps would answer very well in this way. If compression is not followed by the desired effect, mercurial inunction is indicated. The plan I pursue is to have two drachms rubbed in three times in twenty-four hours, over the entire extent of, and a little beyond, the painful region. When the skin becomes surcharged with the ointment, it is easy to clear it again by means of a little oil, and then a second bath is taken. As soon as any fluctuation can be detected, no matter how obscure at any point, the bistouri must be made use of at once, all these abscesses requiring to be largely and promptly opened. At this stage, recourse may again be had to poultices over the suppurating points, and to compression, if the form of the part will allow it. When resolution does not take place, and the suppuration is tardy, it will be right to employ blisters. They may be applied in succession, or simultaneously over the points where the inflammation was most intense, and which are still the most engorged. The larger the blisters, the more certain their good effects, acting either as the best maturatives, or the best resolvents that I know of. In many such cases, I can speak decidedly as to their good effects; having succeeded, in a little time, by means of them, either in dispersing or producing suppuration in masses which seemed to be unalterably indurated. When there is delirium, or great agitation, I also employ them from the beginning; arranging them in such a manner as to cover over the whole of the diseased, together with some of the sound parts. They are removed in twenty-four hours with the epiderm, and the exposed parts are powdered with camphor, in order to protect the urinary passages. The dressing is completed with simple ointment spread on bibulous paper. Mercurial inunction and compression may be conjoined with these means after a few days.

A purgative every third or fourth day, for a week or two, towards the decline of the disease, will be found useful. But medicines of this class should be carefully avoided if diarrhoea or other signs of visceral irritation be present. At a still later period, when the wounds cease to suppurate, it is sometimes

imperative to have recourse to friction with the ioduretted ointment, on account of the doughyness and induration which often persist in several points. Frictions, with small quantities of mercurial ointment, deserve the preference when the induration is extensive; and compression would be still better when it is possible to apply it. The use of the tepid bath is of great value. It need scarcely be added, that from beginning to end, the parts should be kept at rest, and that the regimen and diluents should be regulated according to the state of the bowels, and the degree of general reaction. The wounds, ulcers, and eschars resulting from angeioleucitis require the same treatment as under any other circumstances.

Chronic angeioleucitis.—In the chronic form, the inflammation of the lymphatic vessels present characters so very different from those of the acute angeioleucitis, that it is every where described under other appellations. As it forms, at least, an element, if not the principal lesion in a vast number of the chronic diseases of the skin, it will come more properly into the description of those diseases, but more especially in that of ELEPHANTIASIS.

(*Alf. A. L. M. Velpeau.*)

ANKLE, SURGICAL ANATOMY OF. This word has seldom been clearly defined by anatomists or lexicographers, and for this reason has often been imperfectly understood or improperly employed¹.

¹ Dr. Hooper and Dr. Joseph Fox have omitted this word in their Medical Dictionaries; Dr. Rees's Cyclopædia Britannica, and Dr. Todd's Cyclopædia of Anatomy, both commence the article thus: "ANKLE, SURGICAL ANATOMY OF, JOINT OF," &c. without explaining the meaning of that word. In popular language, this expression is often applied to the lowest and thinnest part of the leg, just above the malleole; more frequently it is used to denote the joint which unites the leg to the foot. This is Dr. Nathan Bailey's and Dr. S. Johnson's definition. Wiseman, one of our best early chirurgical writers, often employs it in this sense, and his example has been followed, more or less, down to the present day; nevertheless, this expression, which is as clear as it is precise, has been rendered obscure by authors applying it to the malleoli, and distinguishing them by the expression of outer and inner ankles. Wiseman and other authors make use of a still more objectionable expression,—such, for instance, as Ankle-bone, Ankle-bones. With a view, no doubt, of putting an end to all ambiguity, medical writers formed the compound word Ankle-joint, which is also an imperfect denomination. Ankle, according to its most common acceptation, meaning the tibio-tarsal articulation, it is evident that ankle-joint gives no additional strength or precision to the word, but, on the contrary, merely commits tautology; it is the same as saying, the joint of the joint which unites the leg to the foot: this word has another inconvenience; it supposes a difference between ankle and ankle-joint, which difference is nowhere to be found. The origin of this word is also unsettled: according to Samuel Johnson it is derived from the Anglo-Saxon *ancleop*, or from the Dutch *ankel*. As Johnson, however, was totally ignorant of all the Northern European languages, but slight reliance can be placed on his Teutonic derivations; as regards the word ankle, Dr. Johnson differs with Bailey, who says that it is taken from Anglo-Saxon *ancleop*, or

As no natural boundaries circumscribe the region of the ankle, artificial ones are assigned to it; it may be said to comprehend all those parts situated two fingers' breadth below, and the same distance above, the lowest part of the extremity of the tibia and fibula. In this small space, objects of the highest practical interest present themselves. The diseases to which the ankle is liable are extremely numerous, very complicated, often highly dangerous, and very difficult of diagnosis.

Fig. 97.

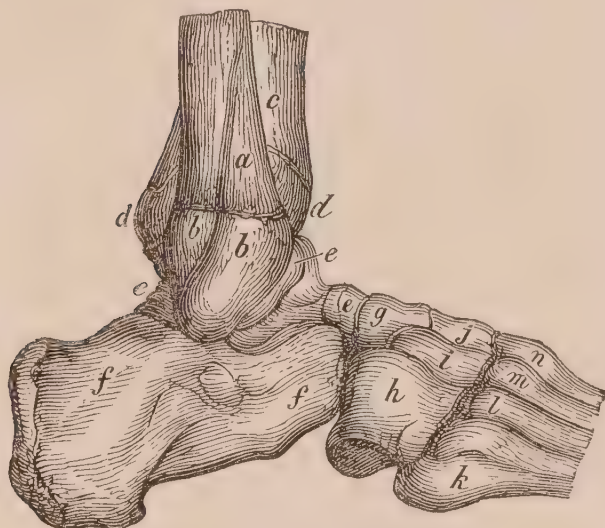


Fig. 97 represents the exact form of the bones of the ankle, viewed from the external side. The subject from whom this foot was taken, was a young female adult whose limbs were extremely well formed. *a*, the fibula; *b b*, the lower extremity of the fibula or its epiphysis, the bone not being completely ossified where the transverse line passes across; *c*, the tibia; *d d*, the epiphysis or lower extremity of the tibia, the transverse line indicates its extent; *e e e*, the astragalus, which has four distinct articulations, one above, with the tibia, one lateral with the fibula, one below with the os calcis, and one before with the scaphoid bone; *f f*, os calcis or heel-bone; *g*, scaphoid bone; *h*, the cuboid bone, which is a little out of its place; in preparing this foot the cuboid was allowed to separate from the os calcis, it is therefore slightly depressed, and too far from the scaphoid and calcis; *i, j*, the third and second cuneiform bones; *k, l, m, n*, the metatarsal bones.

As many valuable rules for the performance of surgical operations may be derived from an accurate knowledge of the outward forms of the human body, we feel it necessary to pay pecu-

liar attention to this subject, which has not yet attracted all the attention it deserves.

The reader will bear in mind that as the outward forms are easily altered by a change in the position of the parts, we shall always describe the ankle region as it is when the leg is nearly at right angles with the foot, as in the vertical and standing position, and that our description is drawn from the male adult of ordinary stature; many inaccuracies will thus be avoided, which from not having attended to these preliminary considerations have found their way into works which treat of this subject.

The ankle region connects the leg to the foot, and presents an irregular oval form; four projections are easily observed in this region, which may be denominated the anterior, the posterior, and the two lateral projections. The diameter of these four opposite points is about equal. The anterior projection is most prominent towards the inside, and is formed by the tendons of the tibialis anticus, extensor longus pollicis pedis, extensor digitorum pedis, and peroneus tertius muscles; and not, as Mr. Brennan says, by the projection of the astragalus. In very muscular persons a slight depression is visible to the eye between the extensor pollicis and digitorum pedis muscles; this depression is felt very distinctly by the finger. On the inner side of the tibialis anticus tendon, the finger recognises a distinct hollow over which the large or internal saphena veins and nerves pass, and where the vein may be securely fixed for bleeding, especially if the pressure be directed towards the edge of the tibia. Many surgeons recommend fixing the vein against the smooth and convex surface of the internal malleole, where it generally slips away from the lancet. On the outside of the peroneus tertius tendon another slight hollow is seen, over which the external saphena vein and nerve mostly pass. If the above-named muscles be put into action, their tendons rise forwards, are much more prominent, and thus increase the antero-posterior diameter of the region. The extensor digitorum and peroneus tertius tendons being more firmly bound down by the annular ligament, are less visible and less displaced.

from the Danish *ankle* (not Dutch). It is rather singular that both these lexicographers should have written this last word differently and incorrectly, especially so as the one copied the other. In the Danish language the word is spelt *ankel* (not *ankel* or *ankle*), and, according to its present anatomical sense, always means the malleoli; it is the *knöchel* of the German, and the *cheville du pied* of the French. In the Dutch it is written "*de enkel*." If the word be derived from the Anglo-Saxon, it ought to be written with a *c*; if from the Danish with a *k*; at present its orthography is quite unfixed, no good reason having been given why one or the other should in preference be used; but whether the word be of Danish or Anglo-Saxon origin, it is easy to show that anatomists have not often given a clear definition of it: we take, for instance, a very popular work on anatomy, where, at p. 65, we read the following lines:—"The lower head of the fibula is broad and flat, and is let pretty deep

into a socket on the side of the tibia; together they form the ankle-joint for receiving the bones of the foot." It is quite evident that Mr. Bell here tells us that the ankle-joint is formed by the fibula and the socket in the side of the tibia; no doubt also, Mr. Bell intended to say, the lower part of the fibula with the lower part of the tibia form the ankle-joint. At page 68, however, our author very properly increases the number of bones to three—the tibia, fibula, and astragalus—which is generally the definition of this joint. Weitbrecht, in his splendid Treatise on Ligaments (not yet surpassed by recent writers), which the illustrious Haller honoured by calling "*insigne opus*," very properly tells us that this articulation is not entirely formed by these three bones. We have followed his example; and under the term "*ankle*" we comprehend all those parts which contribute to strengthen this joint and region.

Fig. 98.

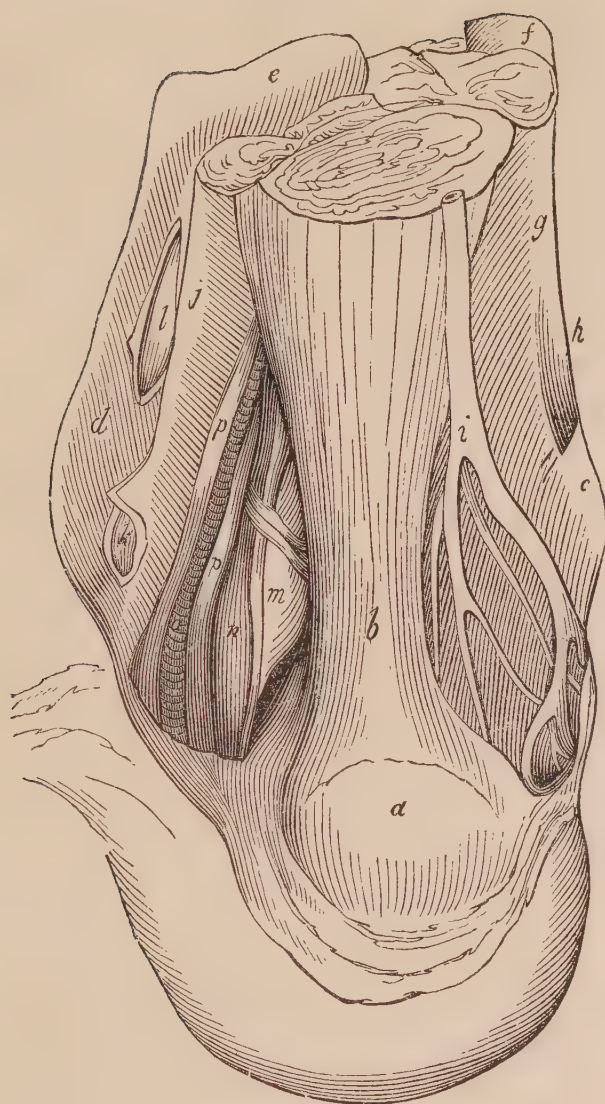


Fig. 98 represents the anatomy of the posterior part of the ankle region. *a*, os calcis; *b*, the tendo Achillis at its narrowest part, where it should always be divided; *c*, external malleolus; *d*, internal malleolus; *e*, tibia; *f*, fibula; *g*, the peroneus longus muscle; *h*, its tendon, exposed by cutting off a portion of the aponeurosis; *i*, the external or posterior saphena vein and nerve behind it; *j*, flexor digitorum pedis; *k*, its tendon in its sheath; *l*, tendon of the tibialis posticus muscle; *m*, the flexor longus pollicis pedis, covered in part by the posterior tibial nerve and vessels; *n*, posterior tibial nerve, with an anterior division passing above the main trunk; *o*, the posterior tibial artery partly covered by its two veins; *p p*, posterior tibial veins.

The posterior projection is formed entirely by the tendo Achillis and adipose tissue; the narrowest part of this eminence is at about one inch from the top of the posterior extremity of the os calcis; it is here also that the rupture of this tendon takes place, and where the surgeon ought always to divide it for the cure of club-foot. This tendon presents a slight curve, which is directed towards the heel. During contraction of the gastrocnemii muscles this slight concavity somewhat disappears; in fact, this projection changes its form at every motion of the ankle; in the perpendicular posture of the leg, the tendo Achillis stands out from the tibia so as to increase the depth of the hollow spaces on each side of it,—when the knee is forcibly bent forwards upon the foot, the posterior projection is much diminished

by the tendon lying close upon the deep-seated parts of this region. The internal malleole forms the inner and lateral projection of the ankle; its broadest part measures about one inch and a half, and is most prominent at its lowest part, where it presents a convex and regular border, bounded below, in all its extent, by a depression which may very appropriately be termed the submalleolar depression. The posterior border of this protuberance is rather acute to the touch, and forms the edge of the groove through which the tendon of the posterior tibial muscle passes; when this muscle acts, the tendon rises above the edge of the tibia, and may be followed by the eye an inch above and below the lower extremity of the bone. The external malleole, which forms the outer and lateral eminence, is the most prominent of the region; its shape is more irregular than that of the opposite malleole, is more posterior than it, and descends lower, giving in this way considerable strength to the joint by wedging in the astragalus. The posterior and inferior extremity of this bone displays a small projection which hides the tendons of the peroneal muscles, which during muscular contraction rise much above the level of the fibula.

Immediately below and anteriorly is a constantly well marked depression, which is bounded above by the extremity of the fibula, below by the extensor digitorum brevis, outwardly by the tendons of the peroneal muscles, which are made very apparent by putting their muscles into action, and inwardly by the peroneus tertius; this hollow corresponds to the space between the astragalus and os calcis. The external, or small saphena vein, with its nerve, generally crosses the external malleole obliquely from behind forwards, and passes over the depression above described. Two other depressions are observed between the tendo Achillis and malleoles; in fact, these bony eminences may be considered as the cause of all the depressions which we observe here; they take off much from the oval form of the limb, and give great cast to the region; they are exceedingly varied in their size and inclination, and determine more than any other part, the beauty of the ankle. The outer hollow is the deepest, owing to the greater or more direct projection of the corresponding malleole. The external saphena vein and nerve sometimes reach the upper part of this excavated surface. The internal depression between the tibia and tendo Achillis, although less deep, is of greater importance to the surgeon, on account of the posterior tibial vessels passing through this hollow, and upon which he may be called to operate; the artery may generally be felt pulsating in about the middle of this space. The outward forms we have endeavoured to describe, are beautifully represented in many of the great masterpieces of Grecian art. The Knife-grinder or Slave, the two Wrestlers in the Tribune of Florence, the Dying Gladiator of the Capitol, the Nile and Laocoon of the Vatican, the

Hercules Farnese of Naples, the Discoboli of the Louvre, &c., are models of anatomical correctness, which we may in vain look for in the most perfect specimens of modern sculpture.

Fig. 99.

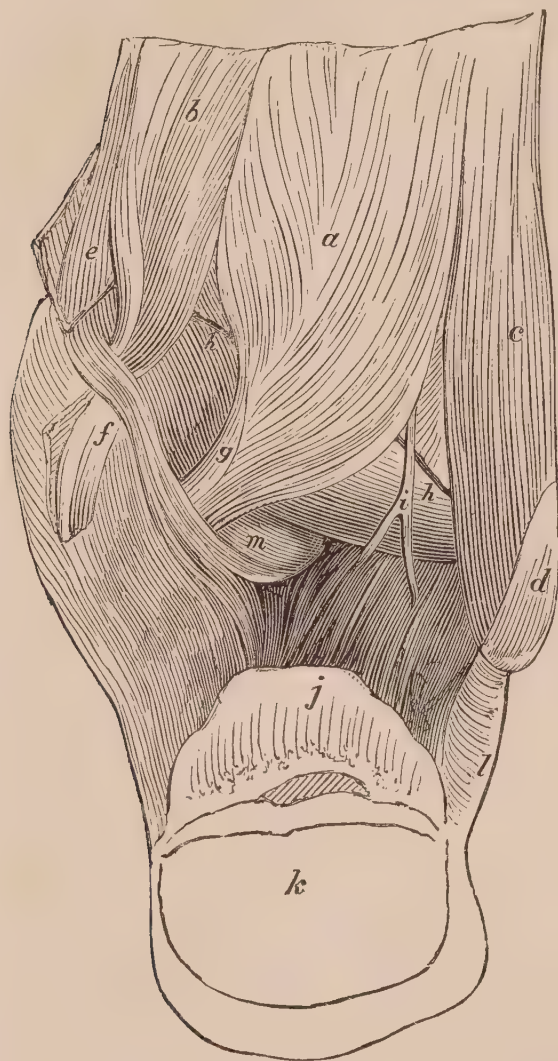


Fig. 99 is meant to give an idea of the deep-seated parts behind the ankle, and also to show the exact upper limit of the tibia-tarsal articulation, which, in this situation, always appears so very high up. *a*, the flexor longus pollicis pedis, which lies directly upon the posterior ligament, and synovial membrane of the joint, which are protected by it; *b*, the flexor longus digitorum pedis also lies close upon the joint; between these two muscles, the posterior tibial vessels and nerves pass towards the foot; *c*, the peroneus longus muscle, which surrounds the back part of the fibula; *d*, the tendon of this muscle, which passes in the groove formed for it in the fibula, lying upon the tendon of the peroneus brevis, and with it passes into the sheath below marked *l*; *e*, tendon of the tibialis posterior muscle, which is covered by the flexor digitorum pedis muscle; *f*, the tendon of the flexor digitorum muscle exposed by cutting open its vagina; *g*, tendon of the flexor pollicis pedis; *h h*, the articulation of the tibia; *i*, the peroneal artery; *j*, the cartilaginous semi-circular extremity of the calcis, upon which the tendon Achillis passes; *k*, the posterior extremity of the calcis; *m*, the lowest and most prominent part of the posterior surface of the astragalus; this projection may generally be felt: between the spaces which are formed by the separation of the muscles, a quantity of adipose tissue exists.

The skin which covers the ankle presents but slight differences to the surgeon's eye. It is thinner upon the surface of the malleoles than elsewhere, more extensible and more

easily folded in front than in any other part; it is less extensible upon the inner than upon the outer ankle, owing to the skin being more firmly connected to the fascia beneath by fibrous tissue, which is inserted into the plantar aponeurosis. As in the vicinity of all other joints, where constant flexion and extension occurs, it presents transverse folds or rugæ before and behind the ankle; in both these aspects also, it is thicker than elsewhere, especially in front, and among the working classes, in whom accidental bursæ mucosæ are here sometimes observed.

The skin lying immediately upon the hard and resisting surface of the malleoles is frequently exposed to injuries from blows, or by fractures of those bones; varicose veins, by ulcerating, often produce sores in this region, which are very troublesome and difficult to heal. In all operations upon the ankle region, and particularly above the malleoles, the surgeon should always remove as little skin as possible, for wounds are constantly more difficult to cure in proportion to the degree of tension and motion of the integuments. In consideration of the transverse rugæ in front of the ankle, Mr. Brennan advises in opening this part to discharge matter, to make the incision transversely; but as there is much flexion and extension in this part, the lips of the wound are much more liable to be separated when we make a transverse, than a vertical incision.

In order to avoid large superficial veins in our operations upon the ankle (as in every other part), the surgeon should always apply a bandage round the leg, when the veins will become apparent, and their exact situation may be noted down, by marking their course with ink; by proceeding thus, many veins can be spared which surgeons are every day wounding unnecessarily.

The sub-cutaneous cellular and adipose tissue of the ankle is bound down in front or connected by means of aponeurotic fibres to the annular ligament, and thus any great accumulation of fat in this situation is prevented, which would evidently impede the motions of the foot and ankle; for this reason also, in children, and fat persons, a transverse furrow seems to pass across the ankle, just below the lower extremity of the tibia; the adipose tissue rising above and below this furrow, renders it still more remarkable. The submalleolar depressions also contain adipose and cellular tissue, which is here also liable to be the seat of œdema. The greatest quantity of adipose tissue is found near the tendo Achillis, and in the posterior lateral furrows, especially in females, where, by its great accumulation, it produces many changes in the forms, and, when in excess, completely destroys the beauty of their outlines. It is not the object of surgical anatomy to describe the minute and superficial vessels and nerves which are found in this region. The surgeon should, however, endeavour to avoid the musculo-cutaneous nerve, which passes before the ankle,

having first divided into two or more branches which below the joint anastomose together by oblique communications.

The fascia or aponeurosis of the ankle region is the continuation of the same subcutaneous envelop of the leg; its office is similar, to keep each part in its proper place; but as there is more danger of displacement of the numerous tendons in this situation, so the fascia is much stronger, and by dividing into several layers forms complete sheaths through which these tendons pass. Although these tendons are so firmly bound down by their vaginæ, yet, by great muscular contraction, these have been ruptured, and thus have the tendons been displaced. Wilson was particularly fortunate in seeing several such cases, and this led him to speak of this accident as a common occurrence, while few other authors speak of it. When the peronei tendons slide over the fore part of the fibula, their action, says he, "is changed; in this new situation their action on the foot will be to bend it on the leg, when in their natural position, it was to extend it:" he adds, "that these tendons may easily be pushed into their proper places, if done soon after the accident, but if not done early, they form a new groove on the fore part of the bone, and the old one is filled up, or otherwise so altered that it cannot again receive them; and thus the pain and lameness may continue for life." "I have seen," he continues, "this occurrence in the living body early enough to return the tendon." In another case, when this could not be effected, he recommended the removal of a portion of the tendon, which was done, and followed by no inconvenience. The same anatomist saw two or three subjects in the dissecting-rooms, which presented similar displacements of these tendons. "The tendons which pass behind the inner ankle are liable to a like displacement." Dr. Adams (Dr. Todd's *Cyclopædia of Anatomy*, Art. ANKLE) has seen one instance of this displacement and several of the former.

An accurate knowledge of these sheaths, which often inflame, and require opening by the knife, is indispensable to the practitioner: ignorance of this subject frequently leads to disastrous consequences¹. If, for instance, where matter is pent up, an incision be made on the inside of these sheaths without penetrating them, little or no relief will be obtained; the pus still remains in the vaginæ of these tendons.

All the tendons in this region are provided with sheaths, which are lined where much friction exists with synovial membranes or bursæ mucosæ, which, by their great smoothness, contribute much to the facility of motion. These membranes are frequently diseased; sometimes they are distended by fluid forming

tumours in different parts of the ankle, according to their situation; this is the most innocent of the affections to which they are liable; they may generally be cured by applying sudden and powerful pressure, sufficient to rupture the bursa; the fluid then becomes absorbed. These tumours frequently present some difficulty of diagnosis to the practitioner, where they are deep-seated, and especially when he is not familiar with the precise situation of the bursæ. Despite of the assiduous and extensive cultivation of anatomy, some parts of the human body attract but little notice; of this, the bursæ mucosæ offer us an example. Few observations appear to have been made regarding these membranes; and the best work which we have upon this subject, is perhaps still, Alexander Monro's valuable treatise, which J. C. Rosenmüller translated into German, in 1799. It is also rather singular that many authors have given representations of these bursæ, very inferior to those which are found in the above-named book. Thus, Caldani in his large engravings has sometimes copied (plate 89) Loder's drawings, which are very inferior in correctness of anatomy to those of Alexander Monro. MM. Bourguery and Jacob, in their splendid work on anatomy, have not done justice to this part of the subject. The best way to study these bursæ mucosæ is to inflate them by means of the blow-pipe. We thus obtain the following dimensions:—At the inside and front of the ankle, we find the tendon of the tibialis anticus muscle, which is generally covered by the cellulo-adipose tissue, and always provided with a large bursa extending two inches above the lowest part of the internal malleole, and one inch below the same part; its length is sometimes much greater,—when amply distended, its width is nearly an inch: the anterior annular ligament, which furnishes this bursa with a sheath, does not bind it down so tightly as it does the other bursa of this region; the finger may easily appreciate the distension of the bursa through the skin. These synovial membranes are generally inserted along the posterior border of the tendons, but not throughout their extent, leaving here and there small spaces, which are mostly of a semicircular form; at each extremity, these membranes present distinct folds, which surround the tendons, and sometimes part of the muscle. These attachments explain why the slightest motion produces such acute pain in cases of inflammation of these bursæ.

The extensor pollicis pedis tendon is surrounded by a large synovial membrane which measures three inches in length and nearly one inch in breadth. I have seen this bursa measure four inches and a half in length; it does not reach so high up the leg as the one just described, but extends much further below, sometimes to within one inch and a half of the articulation of the great toe; the sheath which the annular ligament forms for this tendon is strong and binds it down, so

¹ In suppuration of the synovial membranes it sometimes happens that the tendons slough away. M. Roux saw the peronei tendons come away in a severe case of inflammation of the foot and synovial membrane.

that the bursa when distended is felt more easily above and below the annular ligament, than at its middle, where it offers its greatest thickness.

The anterior tibial artery with its veins and nerve passes down towards the foot, first close behind this bursa of the extensor longus pollicis pedis, then towards its outer side just before it reaches the inner side of the extensor brevis digitorum pedis; in this situation the artery may be tied without injuring the bursæ, if great care be taken. If, on the contrary, this vessel be laid bare while it passes behind the strongest portion of the annular ligament, or even above it, as many anatomists recommend with the idea of avoiding the bursa, invariably the synovial membrane of the extensor pollicis, or of the extensor communis digitorum pedis, will be wounded. In laying stress upon the danger of injuring these bursæ which are situated near the artery, we do not wish to create difficulties for the young operator, but merely to prove that an imperfect knowledge of the situation and extent of these bursæ has caused many errors. For I am well aware that this vessel has been tied several times when no doubt the bursa has been opened, and without endangering the patient's life. Besides, many cases exist, where from accidents, the synovial membranes have been severely wounded, and the patients have, nevertheless, promptly recovered. Very lately, an opportunity occurred of witnessing a severe injury of this sort in my friend M. Donn , the laborious and intelligent author of some interesting papers on microscopical observations, who, while washing his feet, fell through the vase, and thus had both his peronei tendons divided low down; he recovered their use perfectly.

The extensor L. digitorum pedis and peroneus tertius tendons pass in the same sheath, and are, therefore, provided with a common bursa, which is the broadest and shortest in the region; it is about two inches long, extends one inch above the extremity of the malleole, and below, as far as the separation of the tendons one from the other. When distended, it is visibly bound down by the anterior annular ligament, to which it is so adherent that it cannot be easily detached; as this ligament forms a sort of strangulation about the middle of the bursa, the surgeon should always examine above and below this point, when he suspects an accumulation of fluid. The three bursæ just described are constantly found in this region; others, or accidental bursæ, are sometimes discovered in this part. A superficial or subcutaneous bursa mucosa, lying upon the extensor pollicis and digitorum pedis is here met with in cases where considerable pressure has existed above the part; whether these accidental bursæ are of the same nature as the others, I am not at present prepared to decide; however, this bursa is about one inch in length. Another irregular or accidental bursa is sometimes situated upon the astragalus or scaphoid bone,

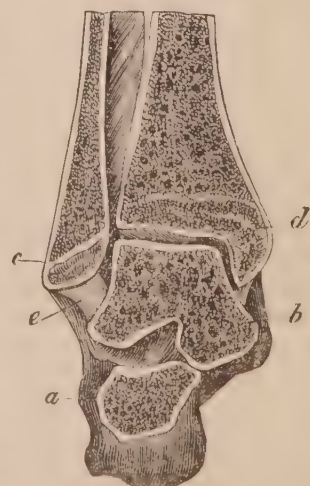
produced probably also by pressure. In the posterior side of this region we find four more bursæ mucosæ, which are situated more deeply than those in front. The tendon of the tibialis posticus muscle, which is the first we discover on the inner side of the ankle, is enveloped by a bursa mucosa which reaches four inches above the lower extremity of the malleole; when distended, the finger may feel it distinctly through the integuments; it rises above the edge of the tibia. The flexor longus digitorum pedis bursa envelopes a portion of the muscular fibres as well as the tendon, and lies partly behind the posterior tibial vessels; for this reason care must be also taken to avoid injuring it.

The flexor longus pollicis pedis bursa covers about an inch of its fibres before its tendon passes the strong vagina; this bursa is extremely thin, and lies immediately behind the posterior tibial vessels and nerves; great care must be taken not to injure it during operations upon these parts.

Proceeding outwards, we observe the bursa of the peronei tendons, which, passing in one sheath, have only one synovial membrane. This bursa is large, rises, when inflated, above the edge of the fibula, can easily be felt by the finger, and extends two inches and a half above the lower extremity of the malleole. In examining the foot of a man who had fallen from a scaffold, I perceived along the course of this bursa, a peculiar sort of emphysematous crepitus: by carefully studying this sensation, I concluded that it was produced by a fluid passing under the fingers; the dissection discovered a fracture of the calcis, rupture of the bursa, which was filled with blood, and an incomplete fracture of the external malleole. I feel quite persuaded that minute inspection of these bursæ will often lead to the diagnosis of similar fractures, and assist in discovering other diseases. A patient was lately sent me, that I might examine his fore-arm, when a very singular crepitation was observed, which seemed to extend along the course of the long muscles of the thumb, and was probably caused by fluid in their bursa which lies above the radius.

Fig. 100.

Fig. 100 is a vertical section of the bones of the ankle. *a*, the os calcis; *b*, the astragalus; *c*, the epiphysis of the fibula; *d*, the epiphysis of the tibia; *e*, the external lateral ligament, descending from the fibula to the os calcis; just within it the line is prolonged to show the interosseous ligament connecting the fibula with the astragalus. The interosseous ligament is also seen connecting the astragalus and os calcis. Between *d* and *b*, the internal lateral ligament is stretched from the tibia to the astragalus.



The articulation of the ankle is formed by three bones, the tibia, fibula, and astragalus ; but as Weitbrecht very justly observes, “*nihilominus tamen ligamenta, quæ pedem in junctura hac coercent, non soli talo (seu astragalo) innascuntur, sed et aliis ossibus, nimirum calcaneo et osse naviculari, quæ ossa vicissim per alia ligamenta sub loco commemoranda cum ipso astragalo firmiter combinantur.*”—(p. 159, loco cit.) The tibia and fibula form together a cavity which receives the pulley-like surface of the astragalus, and thus presents one of the purest hinge-joints of the human body. This articulation, like that of the occipital bone and atlas, is united at nearly right angles, a fact which destroys that analogy which is generally established between the wrist and ankle. The ankle is beautifully constructed for its purposes, great solidity and motion.

With regard to the movements which take place in this joint, much difference of opinion exists. Some anatomists maintain that three motions can be performed in the tibio-tarsal articulation ; viz. flexion, extension, and lateral motion ; others deny the possibility of the last ; and some allow lateral motion, only under peculiar positions of the limb. Thus Wilson, who was a very good anatomist, asserts that the joint of the ankle permits no rotatory motion when the foot is either bent or at right angles to the leg ; but when the leg is raised and the foot is extended, a narrow portion of the astragalus is brought into the hollow formed by the bones of the leg, so that the toe can be pointed to either side.” (Wilson loco cit. p. 156.) This is also the opinion of Mr. B. Cooper, and of many other good anatomists : it is, nevertheless, incorrect. I have endeavoured repeatedly to produce this lateral motion on the fresh subject as well as on the living body, but have never yet succeeded ; in whatever position the limb be placed (when healthy) the two malleoles always prevent this lateral motion, by pressing against the sides of the astragalus. Winslow, a most accurate anatomist, now too little read, has given by far the most perfect description of the different motions of the foot ; and he decidedly affirms that flexion and extension are the only movements permitted in this joint. By admitting this lateral motion, authors have been induced to attribute more or less mobility to the peroneo-tibial articulation, which is described as being covered with cartilage throughout its extent : this is also an erroneous notion—a very small part of this articulation is provided with cartilage ; a synovial membrane and cellular tissue separate these two bones ; all that appears necessary here, is to prevent sudden concussion of the bones ; and, therefore, a sort of elasticity is procured by the cellular tissue which is interposed between them. It is impossible to examine the various erroneous views regarding the motions of the foot and ankle in the present paper ; we must, therefore, confine ourselves to the following

brief observations, which will be corroborated by various pathological facts :—Flexion and extension are the only visible movements of the tibio-astragalian joint. Rotation, or abduction and adduction of the foot, are produced principally within the articulation of the astragalus and os calcis, and a certain degree of similar motion occurs between these two bones and the scaphoid and cuboid bones. The anatomical inspection of these joints, and the direction of many of their ligaments, suffice to set this subject at rest ; the contrary opinion can only be maintained by those who are in the vicious habit of studying the bones in their dried state. The upper part of the calcis is admirably adapted for its two-fold office, of bearing the weight of the body and of allowing considerable lateral motion of the foot upon the leg ; thus its upper surface is divided into three or four articular portions, each separated by a layer of adipose tissue, meant, no doubt, to serve as an elastic cushion for the astragalus, and also to diminish the danger of fracture of this bone, which would probably occur if it were not thus divided, so as to disperse the force of sudden concussions upon its surface.

Fig. 101.

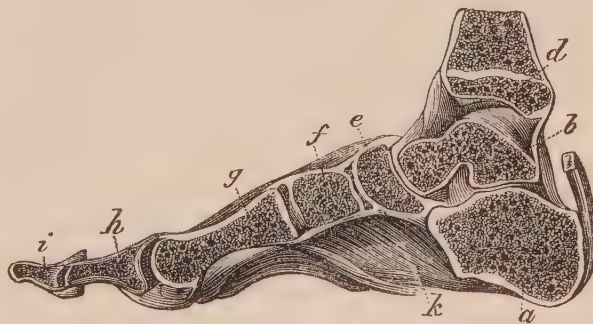


Fig. 101 is a section of the foot, passing through the tibia, astragalus, os calcis, the scaphoid, internal cuneiform, first metatarsal, and phalanges of the great toe, and showing the interior of the several articulations ; a, the os calcis ; b, the astragalus ; d, the tibia ; e, the scaphoid ; f, the cuneiform ; g, the metatarsal bone ; h and i, the phalanges ; k, the muscles of the sole of the foot.

If we take a glance at the numerous disorders of this joint, we find none more common than sprains, and yet we possess very little positive knowledge respecting their precise seat and nature ; hence we may expect a great diversity of opinion. Some authors maintain, that in all violent sprains the ligaments of the tibio-astragalian joint are torn from their bony insertions ; others assert, that the ligaments give way in their middle. Dupuytren, who had several opportunities of dissecting subjects which presented these accidents, tells us that when sprains are not carried to any extent, the ligaments are merely stretched ; on the contrary, when sprains are violent, the lateral ligaments are torn from one or both the malleoles. Wilson, on the other hand, speaking also from his dissections, informs us, that he found “the capsular ligament of the ankle-joint, and one of the lateral ligaments binding the tibia to the foot, lacerated.” In another case, Wilson found the

ligaments thickened, and their pliability greatly diminished¹. M. Cruveilhier, who places nearly the whole of the rotatory motion of the foot in the articulation of the cuboid and scaphoid bones, with the calcis and astragalus, has published the most extraordinary views of these sprains. At page 490, vol. i. of his work on anatomy, he states, "that sprains which are produced by violent and sudden motions of the foot, either inwards or outwards, occur in the above named quadruple articulation, and not in the tibio-tarsal-joint." This exclusive motion is as inconsistent with experience as it is with reason. We are far from rejecting the possibility of sprains existing in that joint, and believe this accident may occur wherever there is motion, because it is frequently caused by violent efforts or exaggerated movements, as well as false steps. Although we have no facts to sustain our opinion, we are inclined to believe that sprains sometimes occur between the os calcis and astragalus, where so much motion is constantly taking place. We cannot leave this subject without exhorting surgeons never to allow any opportunity to escape of minutely examining the nature and seat of this disorder, and of carefully recording the result of their observations.

Dislocation of the ankle is a subject of too vast importance to be treated of in this paper; instead, therefore, of following our predecessors, (the American *Cyclopædia of Practical Surgery*, and Dr. Todd's *Cyclopædia of Anatomy*, where, under "ANKLE," all the dislocations of that joint are explained,) we shall merely speak of certain parts of this subject, referring for the rest to the article "LUXATION." Celsus admitted four sorts of dislocations, "*talus in omnes partes prolabitur*," forwards, backwards, inwards, and outwards; most English writers, from Wiseman down to the present time, have followed his classification. Dr. John Aitkin, in his "*Essays on Fractures and Luxations*," published in 1789, says, "that a backward and forward luxation takes place in the ankle-joint," but never even mentions the lateral dislocations, which are the most common; while, on the other hand, the best authors generally admit the possibility of the backward dislocation.

Notwithstanding the perfect construction of the ankle-joint, the numerous ligaments which bind the various bones together, the strong tendons, their sheaths, and their different layers of fasciæ which greatly contribute to the solidity of the ankle, still violent motions set all these wise precautions of nature at defiance, and produce the most painful and formidable accidents. Dislocations of the ankle are frequently the cause of simultaneous fractures of the tibia or fibula. Some confusion exists regarding the nomenclature of these dislocations; they are sometimes called luxations of the ankle, luxa-

tions of the leg, and luxations of the foot. Foreign writers invariably prefer using the expression, "Dislocation of the foot," therefore care must be taken not to confound these cases, which always correspond to the opposite ones in our nomenclature; for instance, dislocation of the foot forwards would be our luxation of the leg backwards, &c. &c. If we take the astragalus as our guide, we find that this bone can be displaced under very different conditions:—1. It may be separated from the tibia and fibula, and thus afford one example of luxation of the foot or leg. 2. It may maintain its natural position in the cavity of the tibia and fibula, and be separated from its lower articulation with the os calcis, and thus present another form of dislocation of the foot. 3. It may break through all its bands of union, and, as it were, shoot completely out of its place; and, lastly, it may be partially displaced. This last variety is not familiar to many surgeons, and has seldom been noticed by authors. That admirable writer, Jean Louis Petit, is among the first who have spoken of it. M. Roux has kindly permitted me to make use of a manuscript memoir upon this subject, in which he relates the history of four cases of imperfect dislocation of the astragalus. "In all these cases," says M. Roux, "I found the small head of the astragalus dislocated forwards and outwards upon the cuboid bone; the astragalus maintained its position with regard to the tibia and fibula, these bones were not fractured in three of the patients; in fact, the palpable displacement here is caused by the small head of the astragalus leaving the cavity of the scaphoid bone." It might, as this skilful surgeon suggests, be called the most simple form of dislocation. The first case that came under M. Roux's observation was that of a young female, who was admitted into La Charité. Several days after the accident, there was a tumour situated above the cuboid bone, which, by pressing against the skin, had already caused an incipient state of ulceration; the foot was much inflamed, and the great pain which the slightest motion of the limb gave rise to, prevented an attempt at reduction being made. Suppuration around the bone followed, the cartilage which covers the head of the astragalus came away, and the patient recovered: the limb, however, was still very painful and of little use. Some months after this accident, the patient applied to Dupuytren—he at once proposed an operation, which he found most difficult and laborious; he removed the whole of the astragalus. The result was fatal. The second case was that of a middle-aged lady, who, falling down stairs, dislocated the small head of the astragalus, which was easily felt above the cuboid bone. The accident had but just occurred when M. Roux saw her: he applied extension to the foot, and, pressing the head of the astragalus towards its natural situation, "reduced the dislocation with comparative ease." The third observation is that of an Englishman, who, in

¹ Lectures on the Diseases of the Bones, 1820, p. 297.

falling from his horse, met with a similar accident. M. Roux, in conjunction with two other surgeons, endeavoured in vain for a long time to replace the bone; attempts of every sort were made to reduce this dislocation; at last, and without knowing how or why, the bone was reduced; this case is valuable, in as much as it shows the difficulty similar accidents may present. The last opportunity M. Roux had of seeing this accident, occurred in a man who fell from a ladder; there was a compound fracture of the malleole, and a dislocation of the small head of the astragalus upon the cuboid bone. There was too much swelling and inflammation to make a trial at reduction. The foot suppurated; M. Roux entertained hopes that he might saw off the dislocated part of the astragalus; the suppuration however continued, amputation of the leg became indispensable, and the patient died.

These interesting observations naturally suggest a few questions; for instance, it may be asked, why was the head of the astragalus thrown outwards upon the cuboid bone in all these cases? Anatomy will assist, I think, in explaining this circumstance. If the os calcis be made to rotate upwards and inwards, the small head of the astragalus becomes prominent above the scaphoid bone, and is directed outwards towards the cuboid bone; this fact is so evident on the fresh foot, (and may easily be verified upon the living subject), that one is not surprised that such displacement should occur. The ligaments uniting the astragalus to the navicular bone are stronger on the inner than upon the outer side. The astragalus must also have greater difficulty in passing over the scaphoid bone on account of its being a little above the cuboid; there is likewise a slight depression between these two bones where the astragalus perhaps escapes. The tendons of the tibialis anticus, extensor pollicis pedis, extensor digitorum, and peroneus tertius muscles, their sheaths, and the annular ligament, must tend to prevent the bone from escaping in that direction; on the cuboid side there are no such impediments. Another question also arises, and which regards the position of the astragalus with the calcis, or whether the small head of the astragalus can be thrown so far out of its situation, without changing its natural position with that bone. Is the interosseous ligament torn or merely stretched? I have explained these views to M. Roux who entirely agrees with them. In Chassaignac and Richelot's translation of Sir A. Cooper's surgical works, are recorded a number of interesting facts concerning simple and compound dislocations of the astragalus. Dr. Valentine Mott of New York has favoured me with two cases of complete dislocation of this bone which are worthy of notice.

"A man, aged thirty-two, fell from a considerable height upon his feet, and dislocated one ankle compoundly. The astragalus was thrown forwards upon the tarsus, and so entirely detached from all its proper connex-

ions, that it was removed. This man recovered without any of the severe symptoms which usually attend an ordinary compound dislocation of this joint. He walked upon the foot afterwards, having considerable motion preserved in the joint."

"Another man, aged twenty-five, received a similar accident, but the astragalus was not so completely detached from its ligaments. He would not permit it to be removed. He recovered much more lingeringly from the injury, and not without severe symptoms. The bone exfoliated, and he was ultimately able to walk upon this foot."

We shall now examine another contested point in the history of dislocations of the ankle. The existence of a luxation of the foot forwards, or, as we call it, of the leg or ankle backwards, has been denied by many authors. Its occurrence is extremely rare; Boyer, Dupuytren, Sir A. Cooper, Mr. B. Cooper, Dr. Mott, and M. Roux, admit its possibility, but have never met with it in their practice. Dr. Adams, who has written "the Abnormal Condition of the Ankle," in Dr. Todd's Cyclopædia of Anatomy, relates a case of partial luxation of the tibia backwards, which was communicated to him by that practical surgeon, Dr. Colles of Dublin. "In this case the tibia seemed thrown *partially backwards* from the articular pulley of the astragalus, the fibula was unbroken, and was carried backwards with the tibia; the foot, measured from the instep upon its dorsum, was longer than that of the opposite side; the heel was shorter and less pointed; the space in front of the tendo Achillis, near the os calcis was partially filled up; and a hard swelling occupied the lower and back part of the tibia, which was evidently formed by a quantity of callus which had cemented together the fragments of a fracture of the lowest part of the tibia. The leg was shorter than the opposite limb," p. 162.

The anatomy of the posterior region of the ankle somewhat explains why complete and sudden dislocation of the leg backwards so seldom occurs. On the contrary, partial luxation of the tibia backwards, produced gradually, by various causes, is more common than is perhaps generally supposed.

The thickness of the malleoles should also be examined by the surgeon, for in such cases where partial necrosis, fistulous cavities, tuberculous deposits, &c. affect them, he may be enabled to remove a part of this bone, where it will be highly dangerous to penetrate the synovial membrane of the joint; about half of the thickness of these projecting bones may be removed by means of M. Martin's ingenious circular saw, which scoops out a concave hollow in such bones with great facility. I assisted my friend, M. Velpeau, in this operation where the diseased portion of the malleole was neatly removed. M. Velpeau has twice performed this operation. In one case the patient was cured: the other terminated fatally. On account of the great

utility of the malleoles in keeping the astragalus firmly in its cavity, they should always be spared whenever prudence will allow.

M. Seutin, however, was obliged to remove the whole of the fibula, which was diseased throughout: I have seen this preparation, which is probably unique, at Brussels. The patient recovered, and could make use of his leg, which, as M. Seutin remarks, in the printed history of this bold operation, is a proof that the external malleole is not indispensably necessary for progression. M. Roux has also removed the whole of the shaft of the fibula, leaving behind the two extremities. Excision of the lower extremities of the tibia and fibula, rejected by many, is still performed by some enterprising surgeons. Mr. Syme, in his work on excision of bones, appears in favour of it. M. Roux has twice performed it; once fatally, and once with complete success—the patient can make use of his limb.

(*Claudius Tarral.*)

ANKYLOBLEPHARON: (from ἀγκύλη, ‘a band, or bond of union,’ and βλέφαρον, eyelid;) Any adhesion of the eyelids to each other. Adhesions generally take place at the outer canthus; they are less frequent at the inner; and they are very rarely observed either in the middle of the palpebral commissure, or at both its extremities at the same time. Occurring in such various forms, the ankyloblepharon is said to be *complete*, or *incomplete*; the former designation being reserved for those cases in which the occlusion of the lids is perfect throughout. The adhesion may, or may not be formed by the interposition of an adventitious tissue; in the first case the adhesion consists of a membranous band, more or less broad, and this is more especially the character of the congenital ankyloblepharon. Sometimes the adhesion assumes a trellis or lattice form, the opening between the eyelids appearing to consist of numerous small divisions. In other cases, there seems to be no uniting medium, the lids adhering by a faint white line of condensed cellular tissue. An ankyloblepharon is also described as *true* or *false*; the latter signifying the mere agglutination of the eyelids by sebaceous matter, which sometimes occurs. Here the real adhesion has not yet taken place, but it may be produced, more especially if psorophthalmia with excoriations, or any eruption, that of small-pox for instance, be present at the same time. Sometimes the adhesion is not confined to the eyelids alone, but extends to the eyeball itself. This latter form of adhesion is called *symblepharon*, and may exist without the former.

The diagnosis is established by introducing a smooth flexible probe under the eyelids. If the eyeball and lids be adherent, the patient is unable to move the former, and on every attempt to do so, the eyelid becomes wrinkled. The probe may also be used for this purpose, or the upper lid may be raised from the eye in a fold between the thumb and

index-finger, and the patient directed to move the eyeball in every direction. If this can be accomplished, no symblepharon exists. It should, however, be observed, that this indication is often only decisive when the cicatrix extends through the whole eyelid, embracing at the same time both its inner and outer lamella. If the external lamella should not be closely united to the internal by effusion, the former may be raised in a fold, and the eyeball moved beneath it, even though symblepharon in reality exist. In such cases, certainty can only be arrived at by the introduction of a probe.

As the symblepharon is but another form of the same disease, it will not be out of place to include it under the same head, more especially as it presents the same varieties (according as it is complete or incomplete) of membranous frænula, bands, or extensive adhesion between the conjunctiva, and the eyeball. As regards the diagnosis, it is a point of much interest to ascertain if the patient can still distinguish light. If light be not perceived at all, and the globe of the eye is normal, we may conclude that the whole cornea participates in the adhesion. The imperfect symblepharon occurs most frequently in the upper lid.

An ankyloblepharon, even though only incomplete, produces not only great disfigurement, but injures the sight itself more or less particularly when it is of long standing, and extends to a considerable length of the tarsal margins. The retina, deprived of its natural stimulant, light, becomes gradually enfeebled, and paralysis ensues. In complete symblepharon, sight is lost altogether. In partial adhesion of the eyelids, squinting, or even complete obliquity of the eyeball in the direction opposite to the adhesion is often produced; or the palpebral openings assume a peculiar obliquity of direction similar to that of the Chinese. When the lachrymal puncta are closed, stillicidium of the tears, and dryness of the nostril take place on that side. When the disease is congenital, or of long standing, the eyeball frequently becomes atrophied.

The *causes* are either a primitive malformation, (and this case, which is of very rare occurrence, should be called *atresia* of the eyelids,) or adhesive inflammation, arising mostly from burns with quick-lime, gunpowder, boiling oil, steam, &c. The disease is also produced in psorophthalmia attended with excoriations. It was formerly often observed to occur from continually blindfolding in suppurative inflammations of the eyes, especially in small-pox and acute exanthemata, from traumatic lesions of the eye, or eyelids.

The disease is often complicated with other affections, which assume a cachectic, rheumatic, scrofulous, syphilitic, or impetiginous form; with malformations of the eyeball, in which it is small, irregular, or disfigured with cicatrices; with suffusion of the cornea, pannus, &c.

The prognosis depends on the causes, extent, and duration of the disease. Ankyloblepharon is more easily cured, when it has arisen from external, than from internal causes; and as regards situation, is more readily cured when it occupies the middle of the tarsal margins, than when it is situated in either canthus, or when it is complete. When in the outer canthus, it is often extremely difficult after operation to prevent the formation of a new adhesion. The success of the operation is more certain in widely slit eyelids, and prominent eyes, than it is under opposite conditions. Malformation, and an impellucid state of the cornea, or an extensive adhesion of them, often present insurmountable obstacles to the surgeon.

Treatment.—When, in inflammation, there is a tendency to form adhesions between the eyelids, or the eyelids and eyeball, the eye should be frequently opened in order to its being cleansed out by injections of tepid water; an eye-salve, or collyrium, may also be used. Beer prescribes the following to be used several times a day. *R.* Butir. recent. insals. \mathfrak{z} ss.; Hydr. præcipitat. rubr. gr. viij.; Vitriol. alb. gr. 1. Tutiae præparat. gr. x. A solution of Sacch. Saturni, or Zinci sulph. (gr. 1—2) and \mathfrak{z} i Aq. rosæ, with Tinct. opii \mathfrak{z} i. will also be very serviceable. Where the eyelids are already glued together, they should be separated with a probe.

Once formed, both the ankyloblepharon and the symblepharon can only be cured by a cutting operation. In the case of a congenital ankyloblepharon, the operation ought to be performed as soon as possible, in order to procure the admission of light into the eyes. The operation is also required in order to give facility for the application of remedies to the diseased cornea or eyeball. A complete and incurable deformation of the eyeball may also require an operation for the purpose of correcting the disfiguration by introducing an artificial eye. If any inflammation exist, it should be subdued, or any cachectic tendency of the organism, it should be corrected by appropriate remedies before the operation is performed. The operation is contra-indicated when the eyeball is incurably diseased, or malformed to such a degree that no artificial eye can be introduced.

The operation is performed in the following manner: the patient being placed, as in all operations on the eye, either reclining on a slightly elevated chair, or lying down, the upper lid is raised by an assistant, who stands behind the patient. The surgeon placed in front, draws the lower lid downwards with his fore finger, and making the uniting membrane tense, he introduces into the open part of the eyelid a small bistoury, somewhat concave on its cutting edge, and terminated in a fine probe-point two lines in length (Rosas). The bistoury is carried on slowly with its back turned to the eyeball until the adhesion is completely divided. The surgeon may also perform the operation by means of instru-

ments of a different construction, such as a long, slender, probe-pointed bistoury, straight or curved; or a pair of probe-pointed curved scissors; or a probe-pointed director, curved on its smooth surface to the form of the eyeball, with a common bistoury. If the adhesion is established by means of an interposed adventitious membrane, the bistoury is carried as close as possible to the margin of one of the eyelids: this incision terminated, the membrane is detached from the other lid with the scissors. If the adhesion of the eyelids be complete, the assistant lays hold of the upper lid in a perpendicular fold, either in his fingers or with a pair of forceps, and raises it from the eyeball. The surgeon then seizes the inferior lid in the thumb and index-finger of his left hand, and divides the fold by a horizontal incision. Into the opening thus made, he introduces the probe-pointed director or bistoury, and the operation is completed as described above.

When symblepharon exists, the operation is performed at the same time. The upper lid being raised from the eyeball, the adhesions, or membranous bands, are divided with the scissors as closely as possible to the conjunctiva; they are then seized with a pair of forceps, and neatly cut away from the eyeball.

In many cases of symblepharon, the operation fails from the great tendency of the parts to reunite. In order to obviate this, Ammon has performed an ingenious operation on the principle of my method for producing adhesion of the cheeks with the gums. He cuts out a triangular flap from the centre of the eyelid, the base of which is formed by the tarsal margin; this flap is allowed to remain united upon the cornea. The lateral parts of the eyelid are now separated from the eyeball, and brought to unite over the triangular flap by the *sutura circumscissa*. When the margins are firmly united, the triangular flap covering the cornea is removed. After this process, there is but little tendency to reunion in the parts, but it is a plan that can only be adopted where the malformation of the eyelids is not considerable, and where they are not shortened and contracted. In a case of adhesion of the inferior lid with the eyeball, I operated in the following manner:—having separated the eyelid from the eyeball, I cut off the malformed tarsal margin, and formed a large flap of the skin between two parallel incisions, extending from the internal and external canthus downwards. I turned this flap inwards, and united its inner surface by means of sutures. After some time, when the conjunctiva of the eyeball became perfectly formed, I again separated the united inner surface of the flap, and raising it, I thus formed an inferior eyelid, which had no tendency whatever to form adhesions.

After arresting the bleeding by means of cold water, a few drops of pure mild oil are dropped between the eyelids. Several means have been proposed for preventing re-union,

such as raising the eyelids by the introduction of loops of suture, or by the insertion between them of pieces of sheet-lead, gold-beater's skin, &c.; but these measures are too irritating. Some surgeons keep the eyelids asunder by means of strips of adhesive plaster; others touch the margins with nitrate of silver. Rosas recommends the operation to be performed after a long sleep, in order that the patient may be kept awake twenty-four hours; but this recommendation does not deserve serious consideration. He also introduces between the eyelids a plate of wax formed to the shape of an artificial eye, and moistened with oil of almonds; but this precaution also will be unnecessary, if we frequently open the eyelids, and take care to prevent adhesive inflammation by fomentations of tepid water with acetate of lead, or by ablutions of cold water. The use of the unguent. plumbi et zinci may afterwards be required, should suppurative inflammation supervene.

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(*P. T. Dieffenbach.*)

ANKYLOGLOSSUM: (from ἀγκύλη, 'band,' and γλῶσσα, 'the tongue;') Any abnormal adhesion, whether congenital or accidental, of the tongue with the adjacent parts. From this definition, it is obvious that there are various degrees of this affection, all interfering more or less, according to their extent, with the proper functions of the tongue, in sucking, talking, or swallowing. A very common form of the *tongue-tie* consists in a prolongation of the frenum from the base to the tip of the tongue, while its extent from below upwards is too short to allow the tongue to be carried forwards.

The *tongue-tie* is assumed by mothers and nurses to be of frequent occurrence; such, however, is not the case. Whenever there is ground to suspect that this malformation exists in new-born children, it will be proper to institute a careful examination; and this will be best done by closing the nostrils, and forcing the child to open the mouth and cry. If the tongue cannot ascend to the palate, as it ought to do in sucking, but remains immoveable behind the lower jaw, the impediment to the function depends on the condition of the frenum. If now the tongue be raised by the fingers or a slit spatula (an instrument long in use for this purpose) the nature of the case becomes apparent at once.

If, on introducing the finger into the child's mouth, the tongue is found to encircle it firmly like a channel, and to advance over the gums in order to exercise the act of suction, the condition of the frenum forms no obstacle to the child's sucking, and under these circumstances if the infant refuses, or is unable to hold the nipple, it will in all likelihood depend on weakness or disease in the child, or on the size or form of the nipples of the mother.

Accidental adhesions may occur in various parts of the mouth, presenting themselves in the form of bands, or membraniform expansions, in consequence of mercurial ulcers, or violent salivation, during which, from the tongue being greatly swollen, and in close contact with the surrounding parts, the formation of these adhesions to the gums and surface of the mouth is greatly facilitated. Instances have been observed, where the whole of the inferior surface of the tongue was found adherent to the corresponding surface of the mouth. These adhesions are observed to arise in the cicatrization of wounds, burns, &c.

Although in most cases this malformation can only be removed by an operation, it cannot be denied that it has too often been resorted to without the shadow of a necessity for it. Little better than a century back, the midwives were in the habit of cutting the frenum indiscriminately in all new-born children, and in Italy and Germany, they used to allow the nail of the little finger to grow long, in order to make use of it for this little operation which had become so common as to be in some respect merely conventional. If the infant is able to suck, notwithstanding the *tongue-tie*, the operation is unnecessary; should the malformation prevent talking when the child has attained its second or third year, it will be time enough to undertake an operation for its removal.

The operation itself, at whatever period it is performed, is extremely simple. The child, after being fed, is placed in the lap of an assistant, who takes care to hold the head immoveable. The surgeon introduces the fore and middle finger of the left hand, so as to receive the frenum between them, or he uplifts the tongue with Petit's slit spatula, and receives it in the slit; a blunt pointed pair of scissors divides the frenum, in a direction not upwards towards the tongue, but downwards and slantingly, in order to avoid dividing the ranine artery. This is the chief point of importance connected with the operation. Fatal hæmorrhage has been known to follow the division of these small vessels, and the danger is the greater as the flow of blood may go on unperceived. The movements of deglutition, which the child makes to swallow the blood poured into the mouth exercise the action of a pump on the divided vessel, and the blood accumulating in the stomach, nutrition is prevented. Some surgeons employ the scissors only to nick the edge of the fre-

num, the rest of it tearing very easily by the mere motion of the tongue. As regards the incision itself, the rule is, to divide only the thin pellucid parts of the frenum; and if it be very short, the operation will be greatly facilitated by the assistant's pressing the integuments under the chin from below upwards.

Generally, the bleeding is very slight, and ceases spontaneously. If the ranine artery, or others of the sublingual vessels should have been wounded, recourse must be had to cold water, strong styptics, such as solution of alum, aqua Theden, to plugging, &c. The best hæmostatic, however, will be a knitting-needle heated to whiteness, as its application to the bleeding vessels will not prevent the child from sucking afterwards. It will, however, even in this case, be well to abstain from suckling the child for a few hours, lest the bleeding should be renewed. If motions of deglutition are observed during sleep, the mouth should be examined, and if any suspicion should exist of the continuance of the hæmorrhage, the examination should be renewed at short intervals.

In the grown child, or the adult, the operation is performed in the same manner, and reunion is prevented by the introduction of small linen pledgets moistened in oil, by making frequent motions of the tongue, and by washing the separated surfaces from time to time with a solution of honey of roses, &c.

Several complicated instruments were invented for dividing the frenum, by Schmitt, Petit, and Heister; but they have fallen, and very justly, into complete disuse.

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ANKYLOMELE, (obsolete), from ἀγκύλος, 'crooked,' and μήλη, 'a probe.' A curved probe employed in the times of Hippocrates and Galen, for sounding or examining wounds.

ANKYLOSIS. This term is derived from the Greek adjective ἀγκύλος, signifying crooked or bent. Another derivation has been assigned to it from the substantive ἀγκύλη, a species of javelin, or, according to Scapula,

the girth by which a number of javelins was held together; but it is sufficiently evident that the former etymology is the more correct. In either case it is not less erroneous than it is common to spell the word *anchylosis*, as if its primitive contained χ instead of κ.

Ankylosis is the condition of a moveable joint in which motion, both active and passive, is impaired or destroyed. Joints not designed for motion, such as the cranial and facial sutures, or the articulations of the teeth with the maxillary bones, are not said to undergo ankylosis. Nor is a joint said to be ankylosed when passive motion can be communicated to it freely, although its voluntary motion is entirely destroyed. Those cases are therefore excluded from our consideration in which the immobility arises from paralysis, hysteria, and other causes not affecting the joint itself, or the structures immediately surrounding it; but it is of consequence to observe that, even in these cases, a real ankylosis may at length take place as a consequence of long-continued rest.

There are commonly said to be two species of ankylosis, the true and the false; of which the former (sometimes called also hard or osseous) exists when the opposed articular surfaces have become united by bone; the latter, when the impediment to motion is produced by the effusion of lymph or ligamentous tissue in or around the joint, by simple rigidity, &c. The term false ankylosis has little more than a negative meaning, for the conditions which it is employed to indicate are so various that the only information which we can derive from it is, that the bones forming the articulation are not soldered together by bony deposit.

Another distinction is drawn between universal and partial ankylosis. Ankylosis is said to be universal when all, or nearly all, the joints are affected; to be partial when the immobility is confined to one or a very few. Of the former species the examples recorded are not very numerous, and do not furnish any deduction practical or theoretical. Baron Percy placed in the Museum of the Faculty of Paris a skeleton consisting, from general ankylosis, of but one single piece of bone, and it was probably this curious specimen which Boyer described in his treatise on surgery. In the *Annali Universi di Medicina* (1824), an account is given of a patient who, having had gonorrhœa, was not long after his cure attacked by gout and rheumatism, which gradually extended until at length every joint had become affected and ankylosed. The joints of the vertebræ and lower jaw were last attacked. The patient lay constantly in the horizontal position, and life was sustained for some years by fluid nutriment administered through a quill. In the *Lancet*, (vol. i. 1831-2), a case of pure general ankylosis is detailed with considerable care. Bernard Conner (*De Stupendo Ossium Coalitu*) describes another case; and in the *History of the Academy of Sciences* (1716), there is an

account of a child aged twenty-three months, which became the subject of universal ankylosis. Corresponding instances are described in various surgical works ancient and modern, but it is unnecessary to draw up an exact catalogue of them, since a combination of the whole supplies us only with the fact that such things have been. Some of the cases exemplify the effects of long-continued rest, or of arthritis; and as they exhibit nothing more than false ankylosis, are remarkable only from the unusual number of joints affected. The few instances in which all traces of joints have been obliterated by a bony junction of the pieces of the skeleton, are very curious, and, in the present state of our knowledge, inexplicable phenomena. Some analogy to this process may be found in the senile tendency to ossific deposit, and in the profusion of exostoses which sometimes affect weakly children.

Universal ankylosis is a rare occurrence, but its opposite, partial or particular ankylosis, is very frequent. The term partial is employed when the ankylosis is confined to one or a few joints without affecting the skeleton generally; and the remainder of our article must be devoted to this form of the affection, which is so commonly met with; that the phrase, "stiff-joint," is familiar as a household word.

Before treating of ankylosis as it affects the more perfect articulations, those which are endowed with a synovial membrane, it will be convenient to say what little can be said concerning ankylosis of the fibro-cartilaginous joints. In these joints the motion is very limited, and the transition from the normal to the ankylosed condition is easy. The ankylosis is always effected by a deposit of bone, and the new bone is usually of a more dense and compact texture than the old. The conversion of fibro-cartilage into bone seems to be one of the changes incidental to old age, for we rarely examine the body of an old person, especially if his life have been laborious, without finding exemplifications of it in some of the vertebral or pelvic articulations. Thus bony ankylosis of the coccygeal joints often begins to take place in women after the cessation of the menses. In the spinal column this senile change is frequently accompanied by the formation of exostoses, which project from the space formerly occupied by intervertebral substance, and are sometimes of considerable size. They are more common on the anterior surface of the spinal column than on the posterior, but are occasionally met with in the latter situation, where they give rise to an incurable paraplegia, by exerting pressure on the nervous centre.

When ankylosis of the vertebral or pelvic joints takes place before the middle term of life, it is commonly the sequel of an ulcerative process in the fibro-cartilaginous tissue. This ulceration may have been primary. I have seen two vertebræ completely separated by

ulceration of the inter-vertebral substance, while the bones presented only slight traces of inflammation. More commonly, however, the bone is the tissue primarily affected, and the ulceration of the fibro-cartilage is secondary to caries of vertebræ. In this state ankylosis is the only cure, and its formation ought to be promoted by enjoining perfect rest. When this caries affects the spinal column it usually happens, in those cases which recover, that the disease does not affect the whole body of the vertebræ, but is limited to the anterior part, or to one of the sides. Hence a curve is formed by the giving way of the affected side. I have seen an anterior curve produced in this way so extreme that the front part of the body of one vertebra rested upon the front parts of the body of the vertebra next but one below it. It is a curious and beautiful provision of Nature that when this curvature is formed, a quantity of dense bony matter is thrown out during the formation of the ankylosis in the hollow of the curve, so as to give support to the column. On the side opposite to that which has become ankylosed the intervertebral substance is stretched and elongated. Ankylosis of the pelvic joints is not often seen as a consequence of disease, but it sometimes follows the suppuration of the pubic symphysis of which writers on midwifery have given a description.

Ankylosis of the diarthrodial articulations, to which our attention must now be given, is so extensive and complicated a subject that those who have given attention to it, especially if conversant with surgical pathology, feel little surprise at the confused and obscure manner in which it is discussed, even in our most approved surgical treatises. Ankylosis is in some instances a disease against which we are called upon to combat, while in others, it is a happy result which we are not less called upon to promote. From this circumstance considerable perplexity has arisen. Again, the accidents which may in the sequel occasion ankylosis are very numerous and varied, and much confusion has been created by the practice of describing all these varied causes to be productive of one common effect. It is, indeed, true, that in all cases the joint is stiff, but it will be speedily seen that very different structural changes may occasion that stiffness. On the other hand, it would be a tedious labour to describe as many varieties of ankylosis as there are diseases which may remotely originate this affection. The subject will perhaps be freed from some confusion if we confine ourselves to enumerating the proximate or immediate causes of ankylosis; that is to say, the structural changes on which it depends. A constant reference to tissue will give us a very clear principle of arrangement, and with the view of still further facilitating the inquiry, I shall venture to adopt a division not in common use.

I propose to separate those cases of ankylosis which depend on lesion of tissues sur-

rounding the joint from those which are the result of disease in the tissues proper to the joint itself. The advantages which will be gained by employing this line of demarcation are sufficient to warrant its introduction. In the first class will be included the large majority of the cases in which ankylosis is curable; in cases of the second class a cure is very uncommon. Again, in the first class of cases, ankylosis is generally a result to be guarded against, while in the second class it is too often a desirable consummation of a disease otherwise more fatal. The cases of the first class are invariably false ankyloses; those of the second may be either false or true. It is readily granted that these two classes not unfrequently run into one another; that, for example, synovial inflammation may occasion thickening of tissues external to the joint; but there are no arbitrary classifications to which the same objection is not applicable, and in this case the advantages of making the distinction are sufficiently obvious.

We proceed therefore to consider,

A. *Ankylosis, the result of lesion of tissues surrounding the joint.*

This species, which may be termed, for brevity, external ankylosis, results from a great variety of morbid states. Long continued rest is alone sufficient to produce it. A joint is preserved in its healthy state by exercise. When that is withheld the synovial secretion diminishes, the ligaments and tendons become stiffened, the muscles are rigid and contracted. Petit, and others who adopted his opinions, thought that the stiffness consequent on long repose arises from an accumulation of synovia in the joint, and a thickened state of the fluid; but a more inquiring pathology has taught that joints in this state contain a diminished quantity of synovia, and that not at all thickened. Ankylosis from this cause is very commonly seen after fractures; but if the fracture have taken place in the neighbourhood of the articulation, inflammatory deposit has assisted in producing the rigidity. Perhaps the purest example of ankylosis from rest is seen in those Indian fakirs, who, from religious motives, confine themselves for long periods of time to one position. These men have usually several immoveable joints.

Diseases of *cellular membrane* are a prolific source of external ankylosis. A slight wound, an ulcer, inflammation of veins or absorbents, the presence of an abscess, and various other causes may awaken an inflammation in the cellular tissue, which proceeds with varying degrees of rapidity to the effusion of lymph, and until this is absorbed the motions of the joint are greatly limited. It not unfrequently happens that this inflammation, when it occurs in the neighbourhood of a ginglymoid joint affects only one side of the articulation, which is usually that most abundantly supplied with cellular tissue, as the fore part of the elbow or the back part of the knee. In this

case, motion is limited only in one direction, while in the opposite it can be performed almost or quite to the accustomed extent.

The following is an interesting example of external ankylosis dependent on inflammation of cellular membrane. In the middle of January, 1837, I was consulted by a gentleman who stated that in the latter end of the preceding November he had been bitten in the left ham by a dog. The wound was slight, and healed without much difficulty, but a hardness remained which had been gradually extending ever since, and had latterly been accompanied by an inability to move the knee freely. When I first saw him the space between the flexor tendons was extremely hard, the whole leg was swollen and tense, and pitted slightly on pressure; the back part of the thigh, almost to the nates was indurated, while the front part of the thigh and of the knee-joint remained unaffected; the leg could be flexed nearly to the natural extent, but could not be extended beyond a right angle with the thigh, and the motions of the ankle-joint were very limited. The skin of the part affected was hot, and there was some pain on pressure, or when the limb was dependent, but the general health was unaffected. The disease, in spite of the measures taken to combat it, advanced; the right limb became similarly affected, and the contraction of the left leg was the most extreme I ever saw. At length, however, the subacute inflammation of cellular membrane was subdued by position, cold applications, the steam-bath, and a gentle mercurial course; after which the induration and consequent contraction were gradually removed by passive motion, emollient applications with friction, and tight bandaging.

Lesion of *muscles and tendons* is not an unfrequent cause of external ankylosis. Thus, after thecal abscess, we frequently see one or more fingers permanently contracted and motionless. This occasionally arises from sloughing of the tendon, but more frequently from adhesions formed between the opposed surfaces of the theca, and hence arises the necessity of paying much attention to the position of the fingers during the recovery from this disease. The sloughing of tendon and muscle from the presence of abscesses, the involuntary contraction of muscular fibre, if long continued, and the rigidity of these structures consequent upon want of exercise, are other causes of ankylosis. Again, if the right balance of muscular power be overturned, a degree of ankylosis ensues. The uninjured muscle has lost its antagonist, and, meeting with no resistance, is in constant action. It becomes shorter until at length all attempts to restore the member to a proper position would be fruitless without a previous division of the contracted muscle.

If this state of things be not attended to, extreme contractions sometimes ensue, and the joint around which this disturbance has taken place becomes insusceptible both of

active and passive motion, or, in other words, is ankylosed. The most familiar example of this form of disease is seen in the contraction of the fingers which follows upon paralysis of the extensor muscles. The paralysed muscles become small, shrunk, pale, and devoid of irritability, while the flexor muscles, having now no longer any antagonist force, contract themselves until the points of the fingers are buried in the palm of the hand. Some years ago Sir Charles Bell told me that he had been recently consulted by a musician labouring under paralysis of the extensor muscles of the fingers, and had contrived to prevent ankylosis by causing the patient to wear on the back of each finger a piece of watch-spring of sufficient power to keep the finger straight when no effort was made to flex it, but not strong enough to resist the voluntary action of the flexors. The pieces of watch-spring were fastened at one extremity into a bracelet around the wrist, and at the other, into a light ring, worn on the last joint of the finger. This ingenious contrivance, Sir Charles assured me, was so successful that his patient was enabled to resume his occupation, and to play on the piano.

Contractions of *fascia* are not uncommon causes of external ankylosis. These contractions have been assigned to the power which aponeurotic fibres undoubtedly possess of adapting themselves to changes of form and volume, in the parts in which they occur; but it is indisputable that these contractions occur frequently where no such change in form or volume has been perceptible. Laceration of fascia, or long continued rest, may give rise to this contraction; and from the analogy of other structures, it may not be unfair to infer, in our ignorance of the morbid states of this and other tissues of low organization, that fascia is subject to inflammation which produces some rigidity and shortening. Dupuytren has made familiar the ankylosis of the fingers dependent on contraction of the palmar fascia, and recently professor Fröriep of Berlin, (*Preussische Medizinische Zeitung*, quoted in *Brit. and For. Med. Rev.* No. vi.) has pointed out, that ankylosis of the knee-joint sometimes depends on a similar cause, the contraction of the fascia lata, and of the prolongations which it sends off to the knee-joint. Dr. F. thinks that this contraction is most frequently produced by a carious ulcer on the back of the foot, or upon the anterior aspect of the leg. He ascribes the rigidity of the fascia to long-continued rest, with the knee in a bent position; but it is difficult to understand how such ulcers as those of which he speaks should occasion flexion of the knee, unless they excited absorbent inflammation.

The *skin* may give rise to external ankylosis. When extensive sloughing of this tissue has taken place from any cause, as a burn or bruise, the cicatrix which ensues undergoes a contraction which is unhappily very familiar to all. Every surgeon has seen the arm rendered almost useless by ankylosis of the elbow-

joint consequent upon the contraction of a cicatrix.

Exostoses, aneurisms, and tumours, situated in the neighbourhood of articulations, also produce external ankylosis by an action which is too mechanical and obvious to require explanation.

We have thus briefly pointed out the chief proximate causes of the malady under consideration arranged, as closely as possible, under the head of tissue. It would be a task equally tedious and useless to recount the more remote causes. Whatsoever cause destroys the extensibility and easy play of the cellular membrane might be enumerated as a remote cause of ankylosis; but it is manifest that to make such an enumeration here would be to overstep the proper boundaries of this article.

B. Ankylosis dependent on lesion of tissues proper to the joint.

This species may be termed, to contradistinguish it from the preceding, internal ankylosis. It comprehends instances of both false and true ankylosis; but all the examples of the latter class are included under it. In a large proportion of cases it is not a malady which the surgeon can be called on to cure, but a result at which he is happy to arrive. The diseases which occasion it are less numerous than those which give rise to external ankylosis, but far more serious, and will be classified most advantageously under the several tissues belonging to the joint.

The *ligaments* may, in several ways, destroy or impair the motions of joints. Inflammation may be set up in ligamentous tissue by a sprain, a luxation, or a fracture bordering on the articulation, by gout and rheumatism. This inflammation gives rise, at first, to a swollen and softened state of the ligaments, produced by the deposition of lymph between the fibres; subsequently the whole tissue becomes rigid and indurated. When in this state, it has very much the character of cartilage, or fibro-cartilage, and no longer permits the bones to move upon one another with ease and freedom. The dissection of a joint ankylosed by rheumatism illustrates this condition of ligament. Inflammation may be propagated to the ligaments from disease of other articular tissues, and the same process of rigidity and hardening will ensue, but in most of these cases, the impliability of the ligaments is not the only cause of ankylosis. Ossification of ligaments is assigned, by some writers, as a frequent cause of ankylosis, but it is certainly much rarer than is commonly supposed. It is true that the cotyloid ligament of the acetabulum is not unfrequently converted into bone, so as to form a rim round the margin of the articular cavity, but every anatomist is aware that this ligament is fibro-cartilaginous in structure. The most common transformation of true ligamentous tissue is into cartilage. Ossification is not often seen except in old men who have undergone much and great exertion: when it does take place,

it commences at the connexion of the ligament with the periosteum.

Rigidity of ligaments may be produced by long-continued rest. It is necessary to the healthy constitution of organs, that the functions, for the performance of which they are destined, be duly discharged; and when these are not called adequately into play, the organ soon becomes incapable of performing them. Boyer has described another mode in which the ligaments may give rise to ankylosis. He held the opinion, which is to-day not altogether without supporters, that in scrofulous white swelling the bones undergo enlargement. The ligaments, he says, consequently become too short, and hence ankylosis arises. This, though incorrect as to white swelling, since the bones in that disease do not undergo enlargement, may nevertheless hold good with regard to rheumatic joints, in which it is not uncommon to see articular extremities far exceeding the natural size.

Synovial membrane.—A very large proportion of the cases of ankylosis, both external and internal, have their origin in disease of this tissue. When synovitis continues for any length of time, a degree of inflammatory action is awakened in the sub-synovial cellular tissue and adjacent structures, in consequence of which, deposit and thickening take place around the joint. "In long-continued chronic synovitis," says Mr. Wickham, "a deposit is often observed into the ligamentous tissue which invests the capsule, and into the cellular membrane which surrounds the joint, thus giving a degree of firmness and elasticity to the tumour." In addition to this, the flexor muscles undergo that remarkable contraction which is witnessed in almost all joint diseases. This thickening and contraction frequently continue long after the synovial inflammation has ceased, and greatly impair the freedom and extent of motion. Internal ankylosis is sometimes produced by the formation of adhesions between the opposed surfaces of the synovial membrane. It is certain that the inflammation of this tissue does not ordinarily give rise to the effusion of plastic matter; but that it may do so occasionally is a well established fact. Baron Boyer unhesitatingly assigns it as one of the modes in which ankylosis is produced, and cites from Job à Meck'ren, as being probably of this sort, a case in which a stiff joint rapidly became pliable, after being violently straightened by a fall, though previously it had resisted every method of treatment. Dupuytren describes the synovial membrane of a joint which had been implicated in a fracture as red, and exhibiting long membranous bands of adhesion stretching across the articular cavity. Sir Benjamin Brodie states, that he has seen adhesions to each other of the reflected folds of the membrane; and Mr. Mayo describes very clearly cases of ankylosis dependent on such adhesions. I have more than once seen bands of false membrane connecting opposed synovial surfaces. In one beautiful specimen, deposited in the

museum of Guy's Hospital, a thick bridle of cellular membrane of some length, stretches from the cartilaginous surface of the patella to one of the condyles of the femur; and in another specimen, deposited in the same rich storehouse of pathological facts, a very dense and close ankylosis has been formed by adhesions between the synovial surfaces covering cartilage.

Fig. 102.

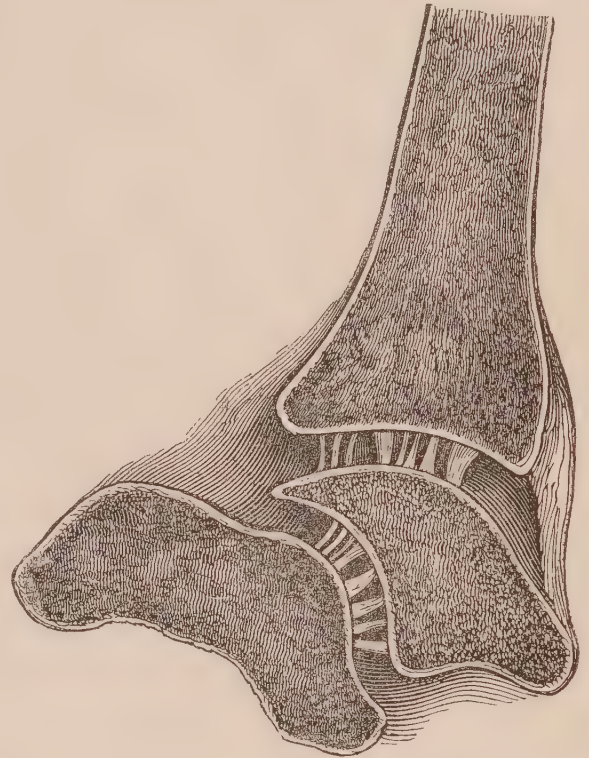


Fig. 102. *Ankylosis of the tibia, astragalus, and os calcis.* From the pathological collection of Mr. Jordan of Manchester. The specimen is curious, from the great regularity of the adventitious membranous bands, connecting these bones with each other.

The ankylosis thus formed may be very firm and unyielding, but the medium of union between the articular extremities is only cellular membrane more or less condensed, while the ankylosis which ensues after ulceration of cartilage or bone, is usually effected either by bone or by ligamentous tissue. A wound of the synovial membrane, if not fatal, very frequently gives rise to ankylosis. Sir Astley Cooper, in describing the consequences of compound fracture into a joint, and of compound dislocation, says, "The bone inflames, the cartilage becomes ulcerated, numerous abscesses are formed in different parts of the joint, and at length granulations spring from the extremities of bone deprived of their cartilages, and fill up the cavity; generally, these granulations become ossified, and ankylosis succeeds; but sometimes they remain of softer texture, and some degree of motion in the joint is gradually regained." (Sir A. Cooper on Dislocations and fractures.) In this case the synovitis, in an indirect way, gives rise to ankylosis, by propagating disease to the other articular tissues; and the same results frequently follow a synovitis which is not traumatic. The cartilage, from its contiguity to an inflamed tissue, ulcerates, the bone is exposed, and ankylosis

is often the happiest termination for which we can venture to hope.

Cartilage.—Ulceration of this tissue is a disease with which we are, as yet, very little acquainted, though the admirable researches of Sir Benjamin Brodie have satisfied the majority of English surgeons of its existence, and not unfrequent occurrence. It is probable that the ulceration may sometimes cease, either spontaneously or through the remedial measures of art, before the cartilage has been extensively removed, and that the joint may be restored to its natural condition, but in many cases, the destructive process is carried on until the bone is denuded. Here, again, ankylosis is a desirable termination. If the patient be of good constitution, the inflammation excited in the bone by the ulceration of the cartilage, may be very slight and transient; in which case, lymph will be rapidly effused from the exposed surface, and adhesions will be formed which sometimes undergo ossification; but more generally assume, in process of time, a ligamentous character. In other cases, where the patient is of a less happy temperament, the bone becomes decidedly diseased; the matter effused from it is either non-plastic, or is prevented from forming adhesions, by the presence of purulent fluid in the cavity of the joint, and the denuded surfaces may be felt to grate on one another. If amputation be resorted to, the joint is found full of a sanious fluid, and the articular surfaces are dark and bare, or covered with soft, tender granulations, but no attempt at ankylosis has been instituted. Mr. Mayo speaks of ankylosis being produced by an effusion of false membrane, from the substance of the cartilage, after an ulceration which had affected only its surface. This is an appearance which I have never seen, nor do I believe it to be of common occurrence. I am well satisfied, that in nine-tenths of the cases of ankylosis following ulceration of cartilage, the bands of adhesion by which the ankylosis is effected, have been effused from the surface of the denuded bone.

Bone.—This structure may be either primarily or secondarily involved in joint diseases. It may be but slightly inflamed from sympathy in the inflammation of a neighbouring tissue, or it may be in a state of idiopathic and most obstinate caries. In either of these cases ankylosis may be the consequence. If the bone be merely inflamed, this result will be attained in the way which has already been described—by the effusion of plastic lymph from its surface, after the removal of the cartilage, and the adhesions which are formed with similar effusion from the opposed articular surface. When the bone, however, is in a state of caries, whether idiopathic or acquired, it too frequently happens that all the efforts of nature and art combined, are incapable of arresting the destructive process, and the patient sinks, or submits to amputation, without any attempt at ankylosis having commenced. If, however, the patient's constitu-

tion be of sufficient strength to bear him through the struggle, or, to use the favourite phrase of our neighbours, “*si la nature, secondée convenablement par l'art,*” arrests the disease, the portions of ulcerating and softened bone are thrown off by granulations which spring up from beneath, the whole cavity of the joint becomes lined by these vascular and fleshy formations which inosculate with one another, and an intimate adhesion is formed between the articular surfaces. In process of time these adhesions, like all newly formed parts become pale from a diminution of their vascularity, and put on the character of ligamentous tissue, or are converted into bone by the deposit of phosphate of lime.

Fig. 103.



Fig. 103. Complete ankylosis of the hip-joint, from a patient of Mr. Briant of Kennington. The joint had been stiff thirty years. The man was a horse-keeper at the Horns' Tavern, and died of phthisis at 35. *a*, trochanter major; *b*, head of the femur, eburnated partly at its neck, and forming one mass of cancelli with the body of the pubis and ischium; *c*, internal and sawed surface of the ilium; *d*, portion of the pubis. From Mr. B. Cooper.

We have here given under an arrangement which seems to us better adapted than any other for comprehension and retention, a general outline of the modes in which ankylosis may be produced, and we have included under their appropriate heads, the anatomical characters of different species of the affection. A few remarks on the conditions which determine the formation of true in preference to false ankylosis will close this part of the subject. It is incorrect to suppose, that osseous ankylosis is a very common occurrence, even after the most severe and protracted diseases

of joints. Crowther, whose experience was very considerable, says, "I have seen but two cases of the knee, and one of the elbow, ankylosed by ossific union," and so far as my own observation extends the inference to be drawn from his testimony is confirmed. The fallacy has probably arisen, partly from the inspection of pathological museums, for which the specimens of osseous ankylosis are treasured up, while those of ligamentous union are often thrown away, and partly from a common, though erroneous belief, that soft ankylosis always admits of some degree of motion. Nor is it correct to suppose, that, where the union has been at first ligamentous, it necessarily becomes, in process of time, bony, by the infiltration of earthy particles. Some years ago, I dissected a knee-joint which had been perfectly motionless for thirty years, and was surprised to find a very dense layer of ligament, and not bone, connecting the articular extremities. Perfect rest, and a proximity of the surfaces of diseased bone, are, probably, conditions essential to the formation of true ankylosis. Hence, in proportion to the number of recoveries from ulcerative disease of the hip-joint, as compared with the number of recoveries from similar disease in the knee-joint, true ankylosis is more frequent in the former articulation than in the latter. I am also inclined to believe, that true ankylosis more frequently follows caries of the articular extremities, than simple inflammation of bone, or ulceration of cartilage. This opinion is founded on the extraordinary tendency to the irregular and profuse deposit of bone which accompanies the recovery from caries. The new deposit is distinguishable from the original formation by its greater density and hardness, and is often thrown into miniature spires and projections which create an appearance, on a small scale, scarcely less beautiful than that of finely carved wood-work. I have in my possession a tibia of this description which is absolutely ornamented by the delicacy and varied form of the new incrustation. After caries of the vertebræ, considerable masses of bone are frequently formed, which arch over from one vertebra to another, and establish what Cruveilhier calls ankylosis by invagination. When true ankylosis has taken place, the bones are united into one piece—that is to say, there is no line of demarcation between them, and their areoles communicate.

The liability of particular classes of joints to ankylosis is a subject on which no very decided opinion can be given. Surgical writers have generally agreed in saying, that the ginglymoid joints are more liable to ankylose than the orbicular, from the size and figure of the articular surfaces, and the number of ligaments and tendons surrounding the articulations. If it be meant by this to intimate, that the diseases which give rise to ankylosis more frequently affect ginglymoid than orbicular joints—as, *e. g.* that the knee is more frequently diseased than the hip, and the elbow, than the shoulder: the assertion is correct;

but this by no means settles the only interesting point in the inquiry, viz. whether there is any thing in the form or office of one class of joints to dispose them to ankylose more readily than the other, when the same causes are operating on both. We shall not however err in affirming, that the joints, such as those of the carpal and tarsal bones, which do not enjoy much motion, are, in proportion, more liable to ankylosis than others.

The liability of particular joints is a subject which does not require much observation. As a general rule, it may be said that we have only to ascertain the degree of a joint's liability to disease, in order to determine the degree of its liability to ankylosis. Some exception, however, must be made to this. Disease of the hip-joint is very common, but ankylosis of that joint is sufficiently rare. To account for this it must be borne in mind, that patients rarely have strength to carry them through the morbus coxarius, if it has been allowed to advance to that stage in which ankylosis is the only cure. A stiff elbow is therefore more common than a stiff hip, because disease of the hip is more frequently mortal than disease of the elbow. This modifying circumstance being taken into consideration, it may be affirmed that, in proportion to the frequency of their diseases, the small joints are more liable to ankylosis than the large, because the affections of the latter are often mortal. Of all the joints, those which most rarely undergo ankylosis are those of the atlas to the dentata, and the inferior maxilla to the temporal bone, and it is remarkable that immobility of these articulations would be far more serious than of any other. A patient was admitted some years ago into Guy's Hospital who presented specimens of both these phenomena. They had gradually come on after exposure to cold, and had been accompanied by rheumatic pains. He suffered great agony in attempting to bend the head, and could take only small quantities of liquid nourishment. He died in the hospital, and the two joints may be seen in its museum. In the same museum, there is another specimen of ankylosis between the atlas and dentata; and in this case, the atlas is joined by bony union to the occiput. Eustachius has described a case of ankylosed lower jaw; and another came under the notice of Cruveilhier, in which the affection had come on during the patient's childhood. She lived, nevertheless, to be an old woman, could speak very clearly, and was able to masticate food by pressing it with the tongue against the sides and edges of the teeth. Ankylosis of the atlas to the occiput is a less uncommon and less serious occurrence. I have seen several specimens of it, one of which was supposed to have been congenital.

The *symptoms* of ankylosis have been almost sufficiently enumerated when it has been described as an insusceptibility of motion, both active and passive. It would be a blunder to describe as symptoms of the affection, those

conditions which tend to produce it; for, to quote Boyer, "les maladies qui produisent l'ankylose ne sont pas l'ankylose elle-même." A crooked and bent condition of the limb is so common an accompaniment of a stiff joint, though not a necessary one, as to have given origin to the name of the disease. The muscles belonging to the affected joint are, if the immobility be complete or nearly so, shrunk and wasted from long disuse. The bones also, in old cases, have become diminished in size. In a case which I have already mentioned, where ankylosis, very complete, though not osseous, had existed for thirty years before the limb was amputated; the femur, now in my possession, does not measure more in diameter than the second finger of a moderate sized hand, and the fibula is about the size of the stem of a tobacco-pipe. It is right to mention, that the ankylosis had taken place in early boyhood, so that, in all probability, the bones had not so much diminished, as they had ceased to grow. When amputation was performed; the patient was a man of middle size, and the other parts of the skeleton had their ordinary development. When the ankylosis is osseous, especially if it be seated in the central joints of the limbs—to wit, the knee and elbow-joints—the patient will be liable to unpleasant jars from any violent shock at the extremity of the limb, and will also be in considerable danger of fracture from comparatively slight causes.

Fig. 104.



Fig 104. *Ankylosis of the knee-joint—left limb. a, the patella; d, the tibia; c, osseous union of these two bones. This and the preceding figure were sketched by permission, from preparations presented by Mr. B. Cooper to Guy's Hospital Museum.*

The diagnosis of ankylosis presents little difficulty as there is only one affection with which it is liable to be confounded. In the early stages of the acute affections of joints,

the pain is often so severe and becomes so intensely aggravated by motion, that the limb is maintained in most perfect quiet by the patient himself, and the whole muscular power is put into play to resist any attempt made by the surgeon to move it. Thus, in acute synovial inflammation, or ulcerating cartilage of the hip-joint, the muscles are sometimes so perfectly rigid during the examination, that the body of the patient may be raised by the thigh without producing any motion in the hip; and Sanson states, (*Dict. de Médecine et Chirurgie Pratique*, Art. *Ankylose*), that he has known an eminent surgeon pronounce a very simple case of arthritis to be one of ankylosis from this circumstance. In order to determine, where there is any doubt in these cases, the surgeon should allow the joint rest for a short time, should engage the attention of the patient on other subjects, and should then endeavour to ascertain, but always by gentle movements, what is the true state of the articulation. By proceeding in this manner, with caution and patience, he may in all cases arrive at a very certain conclusion. But if the diagnosis of ankylosis from other affections be easy, that of the different species of ankylosis is proportionably difficult. It is often next to impossible to decide whether an ankylosis be true or false, for, as every practitioner must have learned by experience, the immobility may be quite as great in one case as in the other. The most valuable diagnostic sign with which I am acquainted is this: when the union is osseous, very strenuous efforts may be made to give motion to the affected joint, without producing any pain, or even the fear of pain; while an opposite result is common if the union be not osseous. It is also said, that the joint remains more swollen when the ankylosis is soft, but I am not able to speak of this positively. The sensations of the patient may afford us some little assistance. If he feels an unusual jarring and vibration of the limb on slight occasions, if he is very careful in the use of it, to avoid little shocks and concussions, it may be inferred that the bones have become cemented together. Another slight indication may be mentioned. If the ankylosis be soft, we shall find, in examining the limb, that when considerable efforts are made to bend it, the muscles which resist motion in the direction intended are called into exercise and become rigid; if the ankylosis be bony, they will remain wholly unconcerned. These are slight indications; but they are all with which I am acquainted, and fortunately the question is not of much practical importance. The diagnosis between the different species of false ankylosis, must, in general, depend on the previous history, which will often enable us to arrive at a very satisfactory conclusion. Thus, if there have been ulceration of cartilage and disease of bone, it may be concluded that the union is by means of ligamentous fibres; if synovial inflammation, without injury of cartilage, there may be cellulo-mem-

branous adhesions between the opposed surfaces of the synovial membrane, or more probably the membrane itself is thickened and stiff, the ligaments have lost some of their extensibility, and deposit has taken place in the tissues around the joint. The only difficulty which can arise in diagnosing between external and internal ankylosis, is in those cases of cellular inflammation, pointed out with great perspicuity by Mr. Wickham, in his work on articular disease, as being liable to be mistaken for affections of the joints. In all other cases, a short inquiry into the patient's previous history will enable us to decide, not only whether the ankylosis be internal or external, but also, if it be external, what has been the primary lesion; whence it will not be difficult to infer the present impediment to motion.

Fig. 105.



Fig. 105. Section of a knee-joint united by soft union. This sketch was taken by permission from the preparation, No. 239 (one of Hunter's), in the Museum of the Royal College of Surgeons. *a a*, the femur with its epiphysis; *b*, the patella; *c c c*, soft uniting substance; *d d*, the tibia with its epiphysis.

The *prognosis* in the affection under consideration can have reference to life only when the inferior maxilla has become subject to it. I have read of one case in which the patient, labouring under this disease, sunk from want of nourishment; but we have already seen in the case cited from Cruveilhier, that this is not an inevitable consequence, and other instances might be adduced, if necessary. Indeed, if the front teeth be extracted, as they unquestionably may be, even when the mouth is firmly shut, it is not easy to conceive how there can be any difficulty in administering a sufficient quantity of soft and pulpy nourish-

ment, not merely to support life, but to support it in considerable vigour. Even in this case, therefore, the prognosis may be favourable, and in every other, life is in no danger. An opinion may, however, be wanted as to the probability of the joint's recovering its proper functions. Where the ankylosis is external, we may usually promise a restoration in process of time, if the affection be not of very ancient date, and do not depend on the sloughing of tendon or muscle. If the ankylosis be internal, we may, in an early stage of the affection, anticipate recovery, if the primary malady has been simple synovitis without ulceration of cartilage, or has been confined mainly to the ligamentous tissue, as in gout and rheumatism; but, where the cartilage has ulcerated, and the bone has been inflamed or carious, no cure can be expected by the application of any ordinary means, for ankylosis is itself the cure. In all cases, the probability of cure depends, in some degree, on the age of the patient, for as life advances the tissues become more rigid; and in a much higher degree on the length of time that the ankylosis has been established. A cure is also effected more easily in orbicular than in ginglymoid joints.

The *treatment* of ankylosis is the last and most important point which claims our attention. From what has been already said, it is sufficiently obvious that no one plan of treatment can be laid down which shall be applicable to all cases of this affection. And additional difficulty invests the subject, from the circumstance, that it is sometimes our business to promote, by every means in our power, the formation of ankylosis, while at others we are not less strenuously called upon to remove it when already formed. The former class of cases will fall first under consideration.

Curative ankylosis is a term which may be employed to denote those cases in which we seek to aid the formation of ankylosis—not to prevent it. Under these circumstances, ankylosis is reparative, or as it has been elsewhere termed, it is “an effort of nature to remedy the effects of disease.” When a process of ulceration has been going on within the interior of a joint, a disorganization is effected which makes it impossible that this complex machine should ever again perform its proper functions; and not only is the joint injured, but even the life of the patient is threatened. Under these circumstances, ankylosis is the only favourable result, and it becomes the duty of the surgeon to promote it in every possible way. The joint should be kept in a state of complete repose. To insure this repose it has been recommended to case the limb in plaster of Paris, but this bricklayer work is often not practicable, and seldom necessary, since the patient is usually unable to accomplish the least motion of the joint. If the remedies employed to subdue the disease prove successful, the reparative action will commence, and the object of the surgeon

will then be to procure such a position of the limb as shall render it most useful when the recovery has been perfected. Thus, if ankylosis is about to take place in the elbow, or any of the finger-joints, the finger or arm should be kept in a state of semiflexion. If the knee be threatened, it ought, if possible, to have slight flexion: it should not be quite straight, because, when one knee is stiff, it is an advantage in walking to have some shortening of the affected limb. Beyond attention to these points, the surgeon has nothing more to do than to watch the slow process by which the limb is restored to all the usefulness of which it is now capable.

It is fortunate that we have more agents at our command to prevent or to remove ankylosis than to promote it. In treating what may be termed, to distinguish it from the preceding variety, *curable ankylosis*, our first object must be to ascertain the original lesion of which we are attempting to remove the result. If this be effected, it will not be difficult to discover suitable methods of treatment, some of which belong so entirely to other branches of surgery, that it is unnecessary to do more than indicate them here. Thus, where a contraction of the skin after a burn or an ulcer is the immediate cause, the cicatrix ought to be divided. Where the joint is rendered motionless by an exostosis, the new formation ought to be removed, if its removal can be effected with safety to the articular cavity. Where an aneurism has induced ankylosis the artery should be tied at the proper place; where a tumour impedes the movements of the joints, it ought, if practicable, to be extirpated. Should any stiffness continue after the adoption of these measures, the method of treatment indicated below for rigidity of synovial membrane, ligament, &c., will be applicable and rarely unsuccessful.

When a *contraction of fascia* is the cause of the ankylosis, Baron Dupuytren has shown that the knife may be used with advantage for the division of the restraining bridle. In the ankylosis of the knee-joint, dependent on contraction of the fascia, and the prolongations which it sends to the knee-joint, Professor Fröriep condemns the resort to a similar operation, and trusts for a cure to extension. It is to be feared, however, that extension alone will be always a tedious and often an unsuccessful method; nor do these appear to be any very strong objections to the use of the knife. The operation would, in all probability, be free from danger; its difficulty, to a competent anatomist, would not be great, and the success with which the corresponding operation has been performed on the finger leads to the anticipation of a happy result. In the after-treatment of such a case, care must be taken to keep the limb as much extended as possible, to commence passive motion at an early period, and to watch the patient for some time after his recovery. It is not necessary, however, to employ violent extension, or to commence passive motion

immediately after the operation. The divided ends of the fascia will probably reunite, but the connecting medium will for some time be soft and easily extensible, so as to admit of the limb being restored, by gentle but steady measures, to its natural shape and mobility.

Where the ankylosis has resulted from *lesion of muscle or tendon*, a cure is not often attainable. It is of course impossible to restore a muscle or tendon which has sloughed away, and it is often almost as impossible to remove the paralysis which has paved the way for ankylosis. In this latter case, however, when the paralysis is recent, a successful effort may be made to prevent the super-vention of the affection by substituting for the destroyed muscular force, a permanently acting mechanical power, in the manner described in the case of Sir Charles Bell, already detailed. When ankylosis is threatened, as a consequence of thecal abscess, it has been recommended to commence motion, either active or passive, at an early period after the evacuation of the matter, and thus to break up the adhesions which are in process of formation between the free surfaces of the theca. The recommendation is more easy to give than safe to act upon. The theca of a tendon is in fact a synovial membrane, and shares in the proneness of that tissue to inflammatory action. The commencement, therefore, of motion at an early period after thecal abscess, is a short and efficacious method for the renewal of the painful malady from which the patient was beginning to escape. "*Haud inexpertus loquor.*" Some time ago, having seen, in rapid succession, several hands which had been rendered useless by ankylosis of the fingers consequent upon thecal abscess, I was induced to recommend a man who was recovering from a very severe attack of this disease, to move his fingers about gently, and at intervals during the day. The next morning, when I visited him, I found him in great pain, his hand and arm tensely swollen, and presenting all the symptoms of a recurrence of the disease. Happily the inflammation was speedily subdued, and no material evil resulted; but I did not again venture to provoke the irritable temper of a theca. It must not be supposed that I condemn the resort to motion after thecal abscess; but I am very sure that it ought not to be employed for some time after the evacuation of the matter, nor until the inflammatory action has fairly subsided. It may then be prosecuted steadily, though gently, and, with the aid of measures shortly to be described as appropriate to rigid joints in general, will often succeed in restoring partially the mobility of the fingers.

Where the ankylosis has resulted from *inflammation of cellular membrane*, the first object must of course be to subdue any remaining inflammatory action. That effected, we have to promote the absorption of the deposit which has taken place, and thus to restore extensi-

bility to the cellular membrane. To this end friction will conduce, and the use of rubefacient liniments, of which I have found the Lin. Camph. Co. to be the most useful, probably, from the mercury which forms one of its principal ingredients. The use of iodine ointment (℞ Iodin. gr. ij. Hydr. Potass. ʒi. Adipis ʒi.) has been recommended, but in the trials which I have made of it in this condition of cellular membrane, I have not found reason to concur very decidedly in the recommendation. Marked advantage frequently follows the local application of the steam-bath, a remedy so cheap and so effectual that it deserves very general use. A tea-kettle full of boiling water, kept hot by an iron heater beneath it, will keep up a sufficient supply of steam for a considerable time. Of course, the steam ought to be confined by a cloth thrown over the limb, and over the spout of the kettle. The same end may be attained by placing the kettle on a small fire, but this method is less convenient. The grand remedy, however, in these cases is pressure, which of itself is often adequate to the cure. A tightly-applied bandage, or what is still better, strips of strong adhesive plaster, firmly incasing the limb, occasion frequently a very rapid disappearance of the swelling and induration. Along with these measures, passive motion must be employed, but with all gentleness; bearing constantly in mind the danger which exists of again awakening inflammation in the cellular membrane.

When the ankylosis has followed upon sprain, luxation, long-continued rest, gout, rheumatism, simple synovitis, or any cause which would occasion rigidity of tissues, (and in this class are included the large majority of cases to which any treatment is applicable) steady perseverance in the use of very simple methods will often effect a cure. The muscles, tendons, cellular and synovial membranes, and ligaments, have lost their natural flexibility, by the restoration of which the ankylosis may be removed. We commence by the use of oleaginous fomentations, or emollient cataplasms, to which the steam-bath, or the long-continued play of a jet of warm water against the joint may be added with advantage. In France, baths are made use of to which the hydro-chlorate of soda or ammonia is added, and it is said with advantage. The joint and the limb above it, so as to include the whole course of the stiffened muscles, ought to be rubbed two or three times every day, and for half an hour at a time after the use of a fomentation, with some oily liniment.

Boyer recommends us to expose the part to the warm vapour of the entrails of sheep, oxen, &c., by thrusting the affected member into the peritoneum of newly-killed animals. The same writer advises the envelopment of the joint in the epiploon or the warm skin of a sheep. I do not deny that these measures may be useful, but they are often impracticable, and always disgusting; nor do I sup-

pose that they possess any marked superiority. There is, however some truth in Benjamin Bell's opinion, that animal fat answers better than vegetable oil as an emollient in stiff joints.

When these measures have succeeded in relaxing a little the stiffened tissues, passive motion ought to be commenced. The patient himself must not be employed in communicating this motion, for he will rarely do it effectively; he will either deceive himself by moving the superior joint, or he will be so much afraid of producing pain that the degree of force used will be inadequate. On the other hand, none but a judicious and patient person ought to be entrusted with the office, and in all cases the surgeon ought to instruct the person who is to be regularly employed, by a practical exemplification of the method to be used. The attempts to communicate motion should always be made on the "gutta cavat lapidem" principle; that is to say, they should be gentle but persevering. Half an hour three times a day after the use of some of the remedies noticed above will be well employed in this way. The attempt should never be so forcible or so long continued as to create positive pain, though generally a slight feeling of uneasiness will be experienced from the commencing efforts. Care also ought to be taken first, that all the normal movements are communicated to the joint, and, secondly, that none other than the normal movements are communicated. In the early attempts, a sort of crepitation is often perceived which ought to afford encouragement to a steady procedure in the method of treatment, but the necessity of avoiding that degree of force which might reawaken inflammatory action cannot be too often inculcated. If these measures be successful, (and a very persevering trial of them ought to be made before abandoning them) we have the satisfaction of seeing the motions of the joint gradually increasing, and the patient should then be directed to commence a cautious use of the limb. It is by voluntary motions that the cure is generally completed.

When the ankylosis is old or very obstinate, we may resort to the use of machines, (such as the apparatus of Lafond) so constructed as constantly to exert some pressure in a right direction, and to prevent any increased contraction. Thus, when the knee-joint is flexed at a right angle, one of Mr. Amesbury's splints may be applied to the back of the joint, and the utmost degree of extension of which the knee is susceptible, without pain, steadily maintained by means of the screw. The measures above recommended, fomentations, friction, passive motion, &c., ought to be persisted in, and on every fresh application of the splint an attempt may be made to increase the extension. Sometimes, to prevent increased contraction, a side-splint may be usefully applied along the whole limb.

Various machines have been used by the

older surgeons to produce forcible extension ; one of which has been pictured by Fabricius Hildanus, but many of them are too complicated to admit of general application. A simple and well-known contrivance in ankylosis of the elbow-joint, when accompanied as it usually is by flexion, consists in placing a weight in the ball of the hand, which the patient should support as long as he is able. Fabricius Hildanus says, that he frequently found this treatment successful. Where the knee-joint has been flexed and ankylosed, I have sometimes employed a similar treatment, by making a patient sit in one chair with his heel resting on another placed at a convenient distance, while a heavy weight was suspended from the knee by a broad belt passing over the front part of the joint.

We have now only to speak of the treatment of those cases of ankylosis in which the bones are united by bone or by dense ligamentous tissue. In the latter case, the connecting medium may be of sufficient length to allow of a certain degree of motion, and a good false joint is gradually formed ; but this happens rarely. The bones are commonly in close apposition, the ligamentous fibres short and unyielding, and the joint altogether incapable of motion. It is sometimes loosely said, that this might have been prevented by communicating motion during the formation of this species of ankylosis : but those who draw their conclusions from practice will feel but little inclination to try so dangerous an experiment. It is true that an ankylosed limb is always awkward, and sometimes not only useless, but an incumbrance. Are we then to make no effort for the removal of this evil ? Some of the French surgeons think that we ought, and have adopted a very summary method,—the ablation of the offending member, or, as it is termed, the “*amputation de complaisance*,” to which we have in England no corresponding technicality. There is no doubt but that amputation may be performed with propriety when the joint in question is small, as, for instance, in the phalangeal articulations ; but English surgeons will agree in the opinion that we have no right to endanger life for the removal of what is merely an inconvenience, and that, therefore, the amputation of a limb because of an ankylosed knee or elbow is inadmissible. Let it be added to this, that according to the testimony of Richerand, Pelletan, and Velpeau, the “*amputation de complaisance*” has, more frequently than amputation from other causes, a fatal termination.

Another method of treating ankylosis of the sort now under consideration has been proposed and carried into effect. I cannot better introduce it than by the following abridgement of a case which has not attracted sufficient attention in this country. A man, who had fallen from the hatchway of a ship into the hold, sustained some injury of the hip-joint, the nature of which does not exactly appear. Seven months after the accident, he

sought relief from Dr. Barton of Philadelphia, who gives the following account of his condition at that period :—

“He was supported by crutches, having the thigh drawn up nearly to a right angle, with the axis of the pelvis and the knee turned inwards, and projecting over the sound thigh, so that the outside of the foot presented forward. There was considerable enlargement round the hip which so much obscured the case, even at this date, as to prevent me from forming any positive opinion as to the real nature of the original injury. From the fixed and immovable condition of the limb it was impossible to ascertain, whether in a straight position there would be shortening, and if any, to what extent. The general feature of the limb bore somewhat the resemblance of that resulting from a dislocation into the ischiatic notch, yet the position in which the great trochanter stood, in relation to the superior anterior spinous process, discouraged such a belief. All things considered, I was rather inclined to the opinion that there had been neither fracture nor luxation, but that the violence of the fall had produced an extensive contusion of the round ligament and joint, and that disorganization had followed the consequent inflammation. On this point, whatever might have been the nature of the accident, I thought I might feel assured that now all articular movement was gone, and that true ankylosis had taken place.”

In this state he was admitted to the Pennsylvania Hospital, where he remained a year, during which time all ordinary methods were employed for the removal of the ankylosis, but without success. At the end of the year, Dr. Barton, finding the case hopeless, unless something extraordinary was attempted for the man's relief, proposed to make a crucial incision over the great trochanter, to divide the bone transversely through this apophysis and part of the neck, and to procure, if possible, a false joint.

“In this proposition four material points presented themselves for consideration ; viz. the practicability of the operation ; the degree of risk to life consequent thereto ; the probability of being able to arrest ossific reunion ; and the reasonable prospect of benefiting the patient thereby. The arguments I adduced in favour of such an operation were these :—That the anatomy of the part did not present any insurmountable obstacle to it. The fear of cutting into a joint was not to be entertained here, since from previous disease, all the characteristics of a joint were gone, synovial membrane destroyed, cartilages absorbed, and an amalgamation of the head of the femur with the acetabulum had taken place. That the shock to the vital system would not probably be greater than is frequently endured from accidental injuries and other operations. That if the opinion commonly assigned as the cause of the formation of false joints after fractures be true, such as frequent motion in the broken ends of the bone, a deficiency of

tone in the system, &c., these agents could be resorted to with promising results."

His colleagues having given their consent to the operation, it was performed on the 22nd of November, 1826, in the following manner.

"The integuments and fascia being divided and raised, the muscles in contact with the bone, around part of the great trochanter, were carefully detached, and a passage thereby made just large enough to admit of the insinuation of my fore-fingers before and behind the bone, the tips of which now met around the lower part of the cervix of the femur, a little above its root. The saw was readily applied, and, without any difficulty, a separation of the bone was effected. The thigh was now released, and I immediately turned out the knee, extended the leg, and placed the limbs side by side, by a comparison of which, in reference to length, the unsound member betrayed a shortening of about half an inch. This might have been caused partly by a distortion of the pelvis. Not one blood-vessel required to be secured. Union by the first intention was not attempted; the lips of the wound were only supported by adhesive plaster and slight dressings. The patient was put to bed, and Dessault's splints were applied to support the limb.

"The operation, though severe, was not of long duration, it being accomplished in the space of about seven minutes.

"In the evening, the patient suffered great pain and was much prostrated; his pulse feeble, stomach irritable, with great restlessness."

From this state of collapse he rallied, and on the twentieth day after the operation passive motion was cautiously commenced. At first it was only employed at intervals of several days, but as it seemed to produce little disturbance was soon used more frequently.

"Sixty days after the operation, the patient (who had previously exerted his muscles in slightly flexing, extending, and rotating his thigh), guided by careful assistants, left his bed, and, aided by crutches, stood erect, both feet-reaching the floor: he thinks he bore ten or twelve pounds' weight on the weakened limb for a few minutes; made an attempt to advance the leg, and did so exclusively, by muscular exertion, then rested on the sound side and rotated the knee, and, as he says, without pain."

On the 31st of January he walked a distance of 150 feet, with the assistance of crutches, and on examining him, "we found him able to perform flexion and extension, abduction and adduction, rotation inwards and outwards, and able to cross the opposite foot: he had then, in fact, regained every movement which the limb originally possessed." In the following month, February, the patient had an attack of erysipelas, on recovery from which he began again to take regular exercise, and to gain strength. On March 1st, it

is said, "He rises in the morning and retires not until night; in the mean time amusing himself by exercise in walking, which he now begins to accomplish by the aid merely of a cane: time only seems to be required to enable him to walk without even this assistance. The following is the degree to which he can perform the movements of his limb with perfect ease: by measurement from a straight line, he can advance his foot twenty-four inches; in stepping backward, twenty-six inches; in abduction, twenty inches; in rotation inward, six inches, and outward, six inches. . . . Upon examining for the space that usually exists between the projection of the great trochanter and the posterior margin of the acetabulum, it will be discovered that it has been filled up by an accumulation of osseous matter, apparently deposited there to prevent displacement of the bones and to form something like a socket.

"The outward contour of the hip resembles that of the sound side, except in the disfigurement occasioned by the extensive crucial incisions.

"When the legs are extended, a slight shortening of the right limb is perceivable, but not sufficient to cause him to limp in walking. The thickness of the blade of the saw taken from the length of the femur, and the subsequent change of the divided surfaces, might have caused this retraction of the limb. When the knees are drawn up, there is an increased shortening, which again disappears as they are extended. By placing the hand over the upper part of the trochanter, and moving the limb, that portion of the bone will be found perfectly at rest; but when the hand is lowered to the part where the joint has been formed, the articulation is satisfactorily felt. The sensation conveyed to the hand is not like that occasioned by two bare surfaces of bone rubbed against each other, but like that imparted by the motions in a natural and healthy joint." (Vide *North American Surgical Journal*, 1827, or the *Lancet* of September 1st, 1827.)

This extract is long but full of interest. I am not aware that any similar case is on record, but I have heard that the same operation has been repeated in America, but with a fatal result. It will be observed that Dr. Barton proceeded on the belief that he could establish a false joint by keeping up motion between the divided ends of a bone. The experiments of Chaussier, Köeler, and Sir Astley Cooper, on animals; the observation on ununited fractures made by Larrey during the campaign of Egypt, and the history of cases of excision of diseased joints, warranted this belief. The false joint is sometimes endowed with structures resembling a cartilage and synovial membrane, but more commonly it is formed by the interposition of ligamentous fibres between the ends of bone, and the motion of the new joint depends on the flexibility of this connecting medium. After excision of a joint the bones are united in this

manner, and it is now sufficiently established, that after this operation the limb is often of great value, certainly of greater than if it were ankylosed. So far, therefore, the argument is in favour of Dr. Barton's proposal; but before we give it our decided approbation, the important question has to be considered, does it endanger the patient's life? If we look again to the somewhat analogous, though more severe operation of excision, we find that it has been almost invariably successful when performed in the elbow-joint, generally, on the shoulder-joint, never, on the hip, where, indeed, it has been but once attempted, and rarely on the knee. There are many reasons, which the reader will be at no loss to call to mind, why an operation such as that proposed by Dr. Barton should be more successful than the operation of excision; but I cannot bring myself to believe, that even the former can be performed on the lower extremities without considerable danger. The large size and depth of the wound must oftentimes give rise to severe irritative fever, or exhausting suppuration. These are risks which the evils of ankylosis do not warrant us in incurring; at least, I should find it difficult to wash from my hands the blood of any patient of mine who died in consequence of an operation for the relief of ankylosed hip or knee. With regard to the joints of the upper extremity, the case is altered, at least so far as the elbow is concerned. On this joint, excision is almost invariably successful, and the operation for ankylosis would be short and bloodless. It would often be sufficient to make a simple horizontal incision at one end of which the needle of the chain-saw might be introduced and brought out at the other, when a few movements of the instrument would complete the operation. At the same time there are but few combinations of circumstances which would warrant us in interfering with an ankylosis, even in the elbow-joint. We ought to be well satisfied that there is no probability of a recurrence of the disease which gave rise to the ankylosis. After scrofulous caries, or what used to be termed white swelling, there is a remarkable tendency to a relapse, so that after several attacks, and as many tedious recoveries, the patient at length succumbs under a fresh invasion, or is compelled to submit to amputation. If the ankylosis, therefore, has followed caries, an operation, unless the joint has been for many years in a quiescent state, would probably excite to growth the dormant seeds of disease. Again, if the arm be ankylosed in a convenient position, it would be unwise to interfere. The operation is, however, not only admissible, but highly desirable, when the whole limb is rendered useless by the fore-arm being permanently flexed to its full extent, so as to lie in contact with the arm, or when the whole limb is perfectly straight. On the whole, therefore, the surgeon will do well to remember that, under certain circumstances, even a densely ligamentous or osseous

ankylosis is not wholly without the pale of surgical assistance.

(*John Blackburn.*)

To the above elaborate and highly practically useful article, may be added a few additional observations relative to the treatment of those ankyloses called partial, (which are as burdensome to the individuals afflicted with them, as true or bony ankylosis); namely those which depend upon organic or functional lesion of tendon or muscle, whether that be 1. from sloughing or adhesions of them, 2. from spasmodic contraction, 3. from organic contraction through paralysis of antagonists, or 4. from contraction owing to long continued rest of the limb.

We may suppose indeed that ankylosis of every kind interests, to a certain extent, all the muscles surrounding the articulation, or at least those which through having been for a long time relaxed by the position in which the joint has become fixed, have contracted themselves; and as in most situations of the body, or at any rate in those joints most prone to ankylosis, the power of the flexors exceeds that of the extensors, we find most commonly that in such incomplete ankylosis, depending partially or wholly upon contracted muscles and tendons, it is the former class of muscles which we have opposing the patient's or our attempts to restore the limb to its natural motion. Yet where the patient has reached the adult age before the occurrence of the disease in and about the articulation, which has given rise to the (partial) ankylosis, we are usually able, unless the contraction, has existed beyond ten or twenty years, to overcome whatever resistance the muscles contracted merely through rest are able to offer, by a diligent perseverance in the means enumerated in the preceding article. Even if the patient be young and the contraction of the muscles through rest have existed but a short time, we may succeed in re-elongating them in the same way; but whether the patient be an adult or youth, if we have persevered weeks, months, or years, without effecting any benefit or a cure of the contraction we have no other alternative than the division of the resisting muscles and tendons, which has been mentioned by the author of the preceding article p. 307; in cases where the balance of muscular power may have been destroyed, and the safety and extensive application of which, was first suggested and demonstrated by Stromeyer, and confirmed by the success which has attended my own practice. I have recently divided the tendons of the biceps femoris, and semi-membranosus and semi-tendinosus muscles for the relief of a partial or so-called ankylosis of the knee joint, consequent upon protracted repose of the muscles and constantly bent position during the tedious progress of disease of the joint. The case was that of a young lady aged eleven; the disease of the joint had commenced between four and five years previously, and after

suppuration and caries in several situations around the articulation, had subsided two years ago, leaving the tibia partially dislocated outwards and backwards, the knee bent to the fullest extent, the patella almost immoveably fixed upon the external condyle of the femur, and the toes rotated outwards; her favourite method of supporting the limb during the progress of the disease, having been the placing the outer side of the leg and ankle upon the opposite thigh close to the inguinal region, where she in fact had pertinaciously held it to guard it against jars, shocks, &c. The most appropriate mechanical means, aided by frictions, baths, manipulations, &c. had been resorted to by the gentlemen who had attended the case, and with considerable diminution of the contracted state of the knee-joint, as when I was first introduced to the patient the leg could be extended almost to a right angle with the thigh, at which point its further extension was arrested by the rigidly contracted flexors of the knee; in which state the limb had obstinately remained for the last twelve months. The ankle joint was also fixed, the foot being in a straight line with the leg, owing to the more powerful posterior muscles of the leg (gastrocnemii, tibialis posterior, flexor longus pollicis, and flexor longus digitorum) having obtained the ascendancy during the long inaction of the limb, over their weaker antagonists. The muscles of the thigh were smaller than those of the opposite side, but the most notable disproportion both of hard and soft parts had occurred in the leg and foot, the tibia and fibula being shorter to the extent of between two and three inches, and the circumference of the leg being less by nearly one half, than that of the sound side. Before resorting to any other than purely mechanical means for the straightening of this limb, many important circumstances suggested themselves for consideration, embodied in the following queries entertained by me at the time.

What is the precise condition of the parts composing the joint?

Is there any alteration in the articular surfaces and ligaments which can impede the bending of the joint?

What share have the evidently contracted gastrocnemii in maintaining the ankylosis of the knee.

Is there no danger of reproducing the disease of the articulation, by performing any operation in its immediate vicinity, and by a comparatively rapid extension of the limb, disturbing the present quiet state of the ligaments? And if the operation prove successful and the knee be straightened, will the patient have a limb (shortened and wasted as are the bones and muscles of the leg,) sufficiently useful to repay her for the pain and risk of the proceeding?

The condyles of the femur were evidently enlarged and the tibia was articulated chiefly with the under and posterior part of the external condyle; yet as by a careful examination,

the leg being held for the purpose as much extended as the ankylosis would admit, it was satisfactorily ascertained that the patella was not adherent by osseous union to the femur, as a slight motion upon its transverse axis could be communicated to it, and the joint could be freely flexed still more, so as to bring the heel almost in contact with the nates; it was highly probable that no difficulty to a greater extension of the limb was offered by the bones and ligaments, for if the latter were so lax as to admit the joint to be easily *flexed* to the full natural extent, they would, supposing that other existing obstacles were removed, for the same reason allow extension to be performed. The only ligaments about which there could be any doubt, were the lig.-post. of Winslow, and posterior crucial; but as these must have undergone some disorganization, or even elongation in order to have admitted a partial luxation of the tibia backwards, they therefore, instead of being rendered tense, and thus opposing *extension* of the limb, would be relaxed by the curative efforts and rather facilitate its reduction. When a quick effort was made with the hand to straighten the limb, there was felt, it is true, a sudden stop to the extension, almost as if there were an osseous hitch somewhere in the joint, and I at first thought it was the patella, which by its firm connexion to the outer condyle offered the obstacle. But agreeing with the diagnostic sign laid down p. 312, the forcible attempt to straighten the limb produced pain along those muscles on the back of the thigh, which resisted motion in the direction intended; they were called into exercise and became rigid, but when tired out, in a few seconds their organic contractibility yielded gradually to the application of the superior power of the hands up to a certain point, beyond which they were incapable of elongation. It was evident to me therefore that the shortened state of the flexor muscles constituted the chief impediment in this case, although the fasciæ and other soft parts surrounding the joint contributed their share to the contracture. To be satisfied however that the state of rest, of from only four to five years, could produce such a permanent shortening of those muscles as to render the bending of the joint impossible, whereas after adult age it is known that by perseverance similar contractions of many years' standing, inducing ankylosis, may be overcome, thus leading us to a conclusion the reverse of which we usually infer from our knowledge of the greater laxity and extensibility of the tissues in youth, we must review and compare the circumstances attendant upon the progress of such cases as respects the muscles, at different ages. Physiologists have assigned various intervals during which the various parts of the animal machine undergo a total change of their component parts; some are of opinion that within seven years, every integrant particle of the body is removed and its place supplied by others; this again as regards the harder and particularly the osseous

tissues has been denied altogether: be the period however what it may, it is probable that any structural change, which may take place in parts rendered unserviceable by accident or disease will be rapid, in proportion to the shortness of the interval during which the deposition and subsequent removal and renewal of parts takes place. If this position be correct, we should suppose that in infancy and youth, setting aside the extensibility of all the tissues in early life, which is of material assistance to us in the treatment of partial ankylosis, a shorter time would suffice to engender structural and inextensible shortening of a muscle in youth than in adult life, as confessedly the processes of decomposition, renewal, and growth, take place in much more rapid succession in early life than at later periods. This supposition, as far as my experience has hitherto reached, is confirmed by observation. If the muscles of a limb have been contracted four or five years from the *constant* repose of the latter in a given position in two individuals, the one a child or youth, the other an adult, it will be found that, apart from whatever interstitial and extraneous deposit of lymph may have taken place about the articulation, the contracted muscles of the child will be less readily stretched out than those of the adult. It may here be observed, that, diagnosing in all such cases of ankylosis from rigidity of muscles, we must be certain that no deception be practised by the patient, and ascertain positively, if possible, whether the limb has really been as much bent as long as may have been asserted; and whether on no occasion whatever, it has been straightened.

The rationale of the occurrence of this structural shortening, is in my opinion as follows.

There exists a certain relation between the growth and development of various parts, and their being constantly and properly exercised in the performance of their allotted function, their being kept in a state of activity; this does not apply merely to the increased thickness of muscles, which follows so notoriously upon augmented action, nor is it a consequence of the nervous energy being supplied to the parts from the nervous centres in a greater or less degree, as it takes place in other parts besides muscle, and where the supply of nervous energy undergoes no alteration; it seems to depend upon a providential law of the animal economy by which parts are increased or diminished according to the necessity for them. Thus when a healthy foot through spasmodic contraction of certain muscles is converted into talipes varus (a most common form of the vulgarly named club-foot,) and has its dorsal instead of its plantar surface turned towards the ground, so that the upper surface of some of the bones of the tarsus touch the earth; a common consequence of so unnatural a mode of progression is that the parts, irritated by contact with the ground, become protected by the formation of a huge bump of dense semi-elastic tissue. This bump, when examined, is

seen to consist first of thickened cuticle and cutis, beneath which is a soft globular cushion of adipose tissue; to this succeeds a fibrous growth, denser than usual, consisting of the hypertrophied fascia and ligaments; immediately upon the bones this appears to become semi-cartilaginous, and lastly from deposition of osseous particles in the latter, the bone appears to be covered with bony incrustations. So that we have formed for the protection of the dorsum of the foot from being wounded by attrition, a mass gradually increasing in density, as it is examined from without inwards. Again, when a foot thus distorted from birth, is restored to its natural form and the patient's heel is made to touch the ground, the dense ligamentous and adipose cushion, which covers the under part of the heel of a healthy foot, becomes here much increased in size. We have innumerable instances of this, in the progress of surgical diseases. On the contrary when muscles, from whatever cause, are thrown into a state of *constant* contraction either passive (from rest of the limb in a certain position), or active (from spasm), not only do they become wasted in bulk, as is commonly stated from want of use, but the muscular fibres become permanently shortened, inelastic, not merely because having been long contracted the individual parts have become adherent to one another, but a period sufficiently long for the complete renewal of their integrant parts having elapsed, the individual fibres are rendered positively shorter, in consequence of the altered relation of parts; and we might as well think of stretching a living biceps beyond its extreme natural length by means of weights attached to it, as to attempt to elongate muscles integrally shortened after long continued contraction, with the aid of manipulations and the best contrived mechanical instruments, unless continued for a time so long that perseverance would be almost impossible. Indeed I have often found that the long continued attempts in such cases to stretch the muscles, have had the same effect, as exercise upon healthy muscles, namely to increase their bulk and consequently their resistance. The reader must bear in mind, that I allude to muscles contracted longer than the time during which physiologists believe the integrant parts are renewed; and pathological experience, I have stated, tells us that this period is long in adults, as long standing partial ankyloses, which have taken place after the attainment of manhood, may be cured solely by mechanical means after many years duration. But in children it is often otherwise; partly on account of the cause I have just discussed, and from another equally striking cause, although neither have, as I am aware of, been noticed by practitioners. During the time that muscles on the one side of a limb are contracted from any cause, and are undergoing interstitial shortening in the manner I have described, the bones advancing gradually towards their full development, shoot out and become lengthened; and thus the dispro-

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I. The size and form of the Cyclopædia of Practical Surgery is similar in every respect to the "Cyclopædia of Practical Medicine," and the "Cyclopædia of Anatomy and Physiology;" it is printed in double columns, with a new type, cast expressly for the purpose, on superfine paper of the largest Royal octavo size.

II. The Work will not exceed Twenty-one Parts, and will be ILLUSTRATED with Wood-cuts and other Engravings, wherever they may be considered requisite. Each of the articles will be authenticated by the signature of the writer.

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